Final
Interim Measure/
Interim Remedial Action for
IHSS 114
and RCRA Closure
of the RFETS
Present Landfill

August 2004

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BZ-A-000906

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ACRONYMS

ACL	alternate concentration limit
ACM	asbestos-containing material
AHA	Activity Hazard Analysis
AL	action level
ALF	Actions Levels and Standards Framework for Surface Water, Groundwater and Soils
AME	Actinide Migration Evaluation
APEN	Air Pollutant Emission Notice
AR	Administrative Record
ARAR	applicable or relevant and appropriate requirement
BMP	best management practice
BZ	Buffer Zone
CAD/ROD	Corrective Action Decision/Record of Decision
CAQCC	Colorado Air Quality Control Commission
CCR	Colorado Code of Regulations
CDH	Colorado Department of Health
CDPHE	Colorado Department of Public Health and Environment
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CHWA	Colorado Hazardous Waste Act
CID	Cumulative Impacts Document
cm/sec	centimeters per second
COC	contaminant of concern
COE	U.S. Army Corps of Engineers
CQC	Construction Quality Control
CRA	Comprehensive Risk Assessment
CWA	Clean Water Act
cy	cubic yard
DCE	dichlorethene
DCL	design concentration limit
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DQO	data quality objective
EIS	Environmental Impact Statement
EPA	U. S. Environmental Protection Agency
ER	Environmental Restoration
ESA	Endangered Species Act
ET	evapotranspiration
FML	flexible membrane liner
ft/ft	feet per foot
ft/yr	feet per year
FY	Fiscal Year

GAC	granulated activated carbon
GCL	geosynthetic clay liner
gpm	gallons per minute
GWIS	groundwater interception system
HAP	hazardous air pollutant
HASP	Health and Safety Plan
HDPE	high-density polyethylene
HRR	Historical Release Report
HSL	Hazardous Substance List
IA	Industrial Area
IAG	Interagency Agreement
ICP/MS	inductively coupled plasma/mass spectroscopy
IGD	Implementation Guidance Document
IHSS	individual hazardous substance site
IM/IRA	Interim Measure/Interim Remedial Action
IMP	Integrated Monitoring Plan
ISMS	Integrated Safety Management System
IWCP	Integrated Work Control Program
K-H	Kaiser-Hill Company, L.L.C.
lb/in^2	pounds per square inch
LHSU	lower hydrostratigraphic unit
LLDPH	linear low-density polyethylene
μg/L	micrograms per liter
MCL	maximum concentration limit
MDL	method detection limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mm/yr	millimeters per year
MOU	memorandum of understanding
mph	miles per hour
mrem	millirem
N	nitrogen
NAAQS	National Ambient Air Quality Standard
NCP	National Contingency Plan
ND	not detected
NEPA	National Environmental Policy Act
NESHAP	National Emission Standard for Hazardous Air Pollutants
NFA	no further action
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
O+M	operation and maintenance
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PA	Protected Area
PAC	Potential Area of Concern
PAM	Proposed Action Memorandum
PCB	polychlorinated biphenyl

PCE	tetrachloroethene
pCi	picocurie
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PM	particulate matter
POC	Point of Compliance
PPE	personal protective equipment
PQL	practical quantitation limit
PRG	preliminary remediation goal
PU&D	Property Utilization and Disposal
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RAO	remedial action objective
RI/FS	Remedial Investigation/Feasibility Study
RCRA	Resource Conservation and Recovery Act
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	RCRA Facility Investigation/Remedial Investigation
SAP	Sampling and Analysis Plan
Site	Rocky Flats Environmental Technology Site
SVOC	semivolatile organic compound
SWMU	solid waste management unit
SWWB	Site-Wide Water Balance
TCE	trichloroethene
TDS	total dissolved solids
TOC	total organic carbon
TSP	total suspended particulates
UHSU	upper hydrostratigraphic unit
USC	U.S. Code
USFWS	U.S. Fish and Wildlife Service
VMT	vehicle-miles traveled
VOC	volatile organic compound
WRW	wildlife refuge worker
WSRIC	Waste Stream Residue Identification and Characterization
WWTU	wastewater treatment unit
WY	Water Year

EXECUTIVE SUMMARY

This Interim Measure/Interim Remedial Action (IM/IRA) decision document addresses the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remediation and the Resource Conservation and Recovery Act (RCRA) closure of the Present Landfill (Individual Hazardous Substance Site [IHSS] 114) and the East Landfill Pond (together the Present Landfill and the East Landfill Pond are also known as Operable Unit [OU] 7 [1,2]) at the Rocky Flats Environmental Technology Site (RFETS). This IM/IRA also terminates the requirements and closes the Notification of Minor Modification to the Modified Proposed Action Memorandum (PAM) for the Passive Seep Interception and Treatment System at Operable Unit (OU) 7 (DOE 1998) and the Final Modified PAM for the Passive Seep Interception and Treatment System at OU 7 (DOE 1995).

Discussions among the Rocky Flats Cleanup Agreement (RFCA) parties regarding the State of Colorado Covenants Law have confirmed that CHWA/RCRA post-closure requirements are not regulated under RFCA and that accelerated actions are not final remedial decisions. Therefore, the Covenants Law is not an applicable or relevant and appropriate requirement (ARAR), and post-closure care is not specifically addressed in this IM/IRA. This IM/IRA includes a discussion of the elements of post-accelerated-action monitoring, institutional controls, and long-term stewardship for informational purposes. Post-closure care requirements will be incorporated in either a post-closure permit or some other enforceable mechanism at a later date.

The Present Landfill remedial action objectives (RAOs) were developed to prevent human and ecological exposures to fill material, achieve RCRA interim status closure, and protect surface water quality. To achieve these objectives, a RCRA Subtitle C compliant cover will be placed over the landfill thereby preventing direct contact with fill material, providing a layer between surface water runoff and the fill material, and reducing the infiltration of precipitation. The Present Landfill seep water emanating at the Present Landfill will continue to be treated through a modified passive seep interception and treatment system. The East Landfill Pond will remain and no changes will be made to the pond's physical configuration; however, the East Landfill Pond Sediments will be removed and placed under the RCRA Subtitle C-compliant cover.

Evaluation of surface and subsurface soil data indicate that potential contaminant concentrations are less than RFCA wildlife refuge worker (WRW) action levels (ALs). Groundwater monitoring at the Present Landfill over the last 18 years has shown that the landfill is not impacting downgradient groundwater quality. Groundwater immediately downgradient of the East Landfill Pond will be further evaluated in the RFETS Groundwater IM/IRA.

In accordance with Paragraph 95 of RFCA, National Environmental Policy Act (NEPA) values have been incorporated to satisfy the requirement for a "NEPA equivalency" assessment of environmental consequences resulting from the proposed action.

[1] Operable Unit 7, as defined in the 1991 InterAgency Agreement (IAG) consists of IHSS 114 and 203, and the East Landfill Pond. IHSS 203 has received a No Further Action (NFA) determination. Therefore, OU 7 represents IHSS 114 and the East Landfill Pond in this decision document.

[2] Based on modifications to RFCA, dated May 28, 2003 (approved June 5, 2003), OU 7 is now part of the Buffer Zone OU and is no longer distinguished separately as OU 7.

1.0 INTRODUCTION

This Interim Measure/Interim Remedial Action (IM/IRA) decision document addresses the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remediation and the Resource Conservation and Recovery Act (RCRA) closure of the Present Landfill (Individual Hazardous Substance Site [IHSS] 114) and the East Landfill Pond (also known as Operable Unit [OU] 7 [3,4])at the Rocky Flats Environmental Technology Site (RFETS or Site). Closure of the Present Landfill is subject to RCRA/Colorado Hazardous Waste Act (CHWA) interim status unit closure requirements, consistent with the Rocky Flats Cleanup Agreement (RFCA) Attachment 10.

Discussions among the Rocky Flats Cleanup Agreement (RFCA) parties regarding the State of Colorado Covenants Law have confirmed that CHWA/RCRA post-closure requirements are not regulated under RFCA and that accelerated actions are not final remedial actions. Therefore, the Covenants Law is not an applicable or relevant and appropriate requirement (ARAR) and post-closure care is not specifically addressed in this IM/IRA. Appendix A has been included as part of this IM/IRA to describe the elements of post-accelerated-action monitoring, institutional controls, and long-term stewardship for informational purposes.

This IM/IRA terminates and supersedes the requirements of the Notification of Minor Modification to the Modified Proposed Action Memorandum (PAM) for the Passive Seep Interception and Treatment System at OU 7 (DOE 1998) and the Final Modified PAM for the Passive Seep Interception and Treatment System at OU 7 (DOE 1995).

Located near the Present Landfill (IHSS 114) are the Landfill Pond Spray Areas (IHSSs 167.1, 167.2, and 167.3) associated with OU 6, the Walnut Creek Drainage, Improper Disposal of Diesel-Contaminated Material at the Landfill (Potential Area of Concern [PAC] NW-1502), Improper Disposal of Fuel-Contaminated Material at the Landfill (PAC NW-1503), and Improper Disposal of Thorosilane-Contaminated Material at the Landfill (PAC NW-1504). All of these IHSSs and PACs have been approved for No Further Action (NFA).[5] IHSS 167.1 was approved in 1999 according to the 2001 Annual Historical Release Report (HRR); IHSSs 167.2 and 167.3, PACs NW-1502 and NW-1503 were approved for NFA by both the Colorado Department of Public Health and Environment (CDPHE) and the U.S. Environmental Protection Agency (EPA) in a letter dated February 14, 2002. PAC NW-1504 was approved for NFA by both CDPHE and EPA in a letter dated September 27, 2002. (Note: IHSSs 167.2 and 167.3 were administratively transferred from former OU 6 to OU 7 on May 27, 1993.)

To aid in the understanding of the conditions that exist at the Present Landfill, the following definitions are provided:

[3] Operable Unit 7, as defined in the 1991 InterAgency Agreement (IAG) consists of IHSS 114 and 203, and the East Landfill Pond. IHSS 203 has received a No Further Action (NFA) determination. Therefore, OU 7 represents IHSS 114 and the East Landfill Pond in this decision document.
[4] The term NFA is used here consistent with the terminology used at the time of the NFA designation. The U.S. Department of Energy (DOE) acknowledges that the current term used is No Further Accelerated Action (NFAA).
[5] Based on modifications to RFCA, dated May 28, 2003 (approved June 5, 2003), OU 7 is now part of the Buffer Zone OU and is no longer distinguished separately as OU 7.

- **The East Landfill Pond** is clearly identified on Figure 2 in this IM/IRA.

- **The No Name Gulch drainage** is a drainage tributary to North Walnut Creek in Big Dry Creek Segment 4a from its source to the confluence with Walnut Creek approximately 0.8 mile west of Indiana Street. No Name Gulch is the drainage immediately north of the drainage containing the A-series ponds at RFETS, and includes all tributaries, ponds, and reservoirs such as the East Landfill Pond.

- **Present Landfill leachate** is the liquid resulting from infiltration of precipitation through the Present Landfill.

- **The Present Landfill seep** is the surface expression of groundwater emanating from the Present Landfill at or near surface water location SW00396. The Present Landfill seep water also contains Present Landfill leachate.

2.0 SITE BACKGROUND

RFETS is a government-owned, contractor-operated facility formerly used for the fabrication of miscellaneous weapons components for national defense. The 6,550-acre site is located in Jefferson County, Colorado, and approximately 16 miles northwest of Denver. The site occupies approximately 10 square miles (Figure 1).

Centrally located within the RFETS boundary is a 400-acre security area referred to as the Industrial Area (IA). The IA contains approximately 400 buildings along with other structures, roads, and utilities, and is where the majority of RFETS mission activities took place between 1951 and 1989. The remaining 6,150 acres consist of undeveloped land used as a Buffer Zone (BZ) to further limit access to the operations area. The Present Landfill (IHSS 114) and the East Landfill Pond are located north of the IA within the BZ, at the western end of the No Name Gulch drainage (Figure 2).

2.1 Operational History

The operational and historical information provided in this section is from the Final Phase I RCRA Facility Investigation/Remedial Investigation (RFI/RI) Work Plan (DOE 1991), unless otherwise noted.

The Present Landfill is located in the No Name Gulch drainage, at the western limit of headward erosion and pediment dissection. Beginning in 1968, a portion of the natural drainage at the headwaters of the No Name Gulch drainage was filled with soil from an on-site borrow area to a thickness of approximately 5 feet to construct a surface on which to begin landfilling operations. The landfill does not have a bottom liner. Waste delivered to the landfill was spread across the work area, compacted, and covered with a daily soil cover, eventually filling the valley to the top of the pediment, at approximately 6,000 feet. Some waste material is confined laterally by the bedrock slopes of the valley and by an existing surface water diversion ditch.

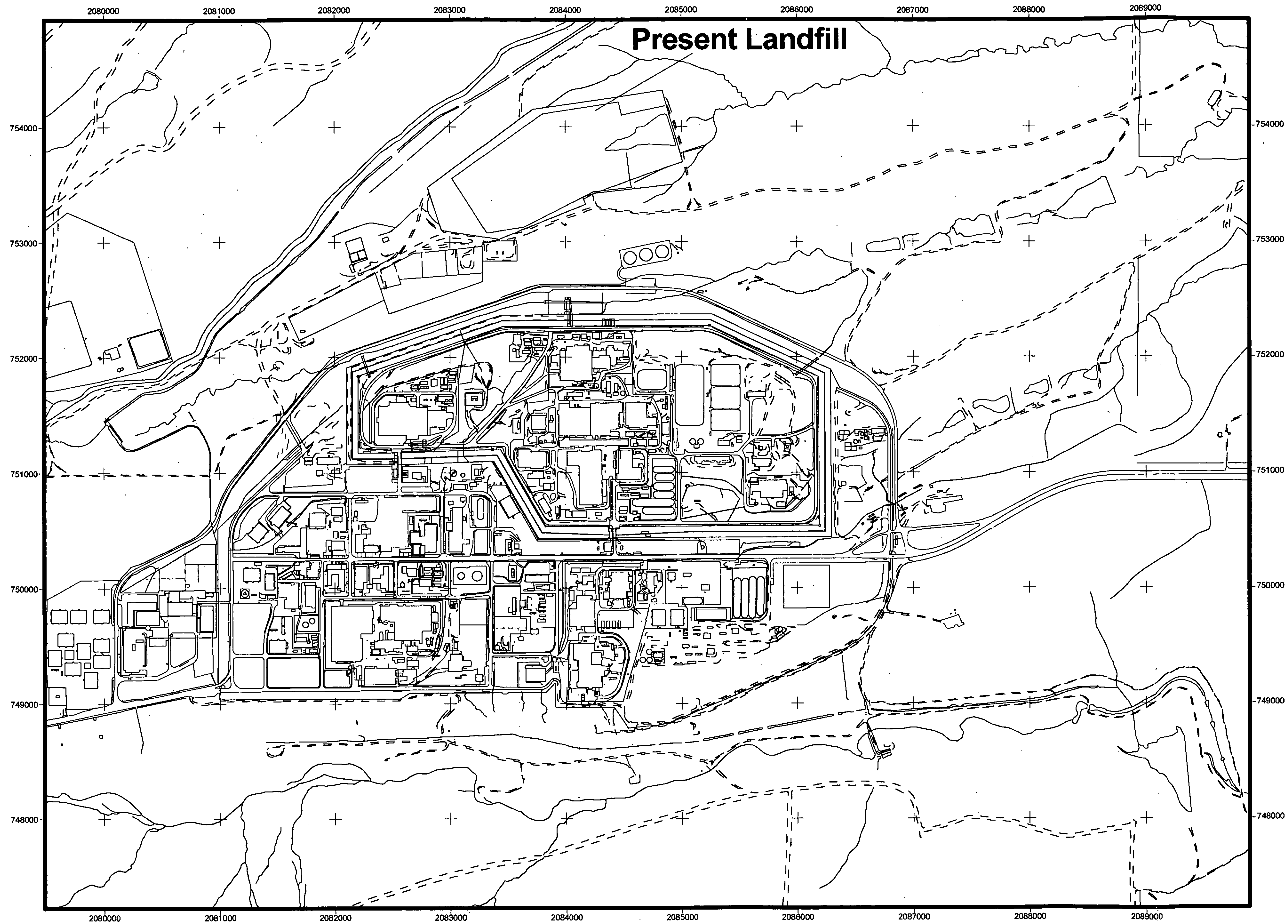

Figure 1
Rocky Flats and the Present Landfill

KEY

- Present Landfill (IHSS Boundary)
- Bldg
- Lakes and ponds
- Fence
- Paved area
- Dirt Road
- Stream, ditch, or drainage

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N

300 0 300 600 Feet

Scale = 1:10,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

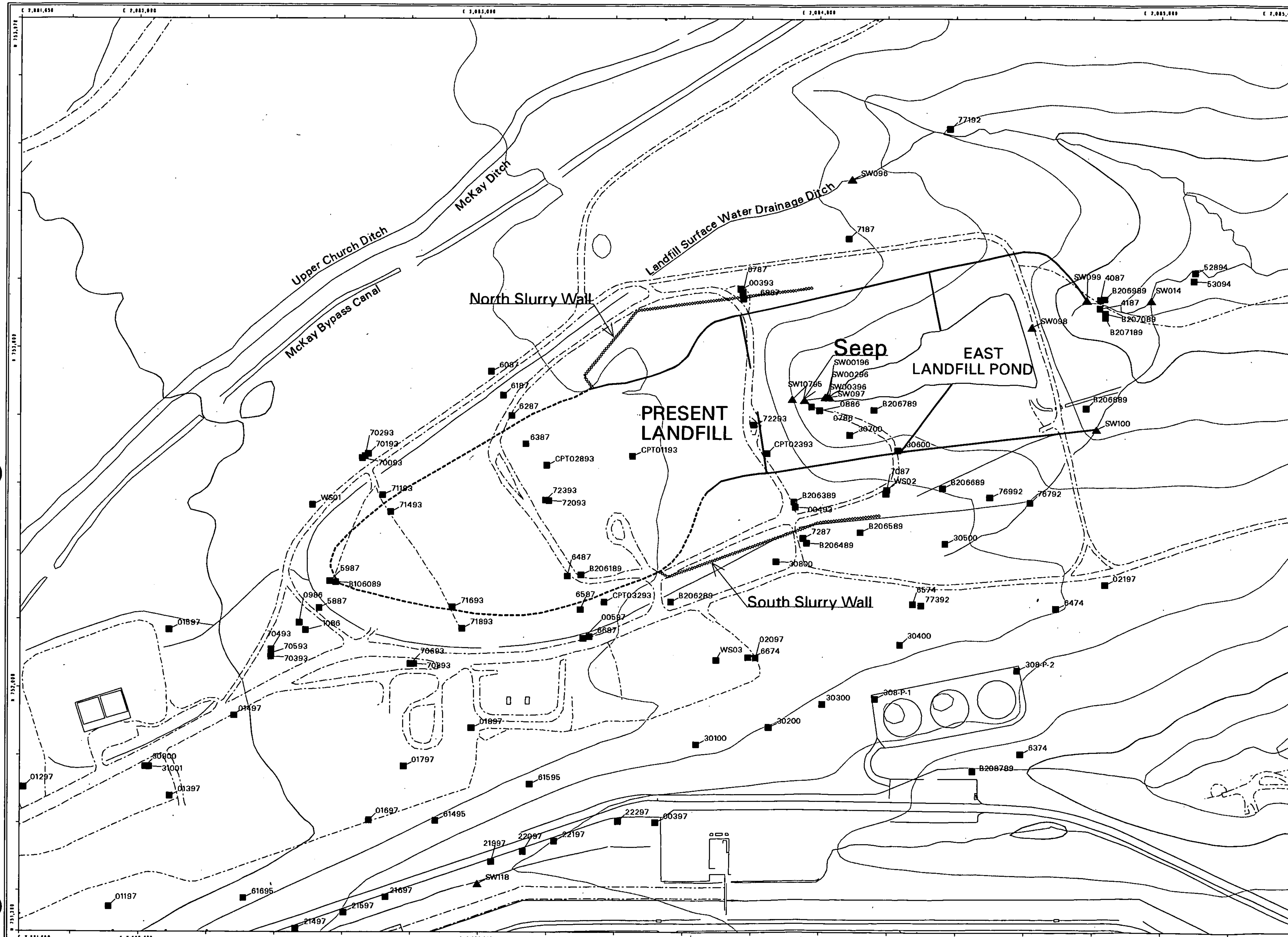
RADMS

Prepared for:

KAISER•HILL COMPANY

PLbase3-10-03sps.apr March 2003

Figure 2
Present Landfill



EXPLANATION

- Well Location
- Surface Water Sampling Station
- Slurry Wall
- GW Intercept System - Perforated
- GW Intercept System - Non-Perforated
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Topographic Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95
Topographic contours were derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

Scale = 1 : 3560
1 inch represents approximately 297 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: CH2MHILL

Prepared for: KAISER-HILL

March 07, 2003

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The Present Landfill was placed into service in August 1968 for the disposal of solid waste, including office trash, paper, rags, personal protective equipment (PPE), construction and demolition debris, scrap metal, empty waste containers, used filters, and electrical components. From 1968 to 1978, the landfill received approximately 20 cubic yards (cy) of compacted waste per day. In October 1972, the policies concerning the disposal of waste at the landfill were reviewed and determined to be in accordance with applicable state and federal regulations (Woodward Clyde 1990).

The Health Physics Operations unit of the Rocky Flats Plant began a program in 1973 to monitor the waste for radioactivity after it had been dumped and before compaction and burial. A logging procedure was instituted at that time to maintain control of where the waste originated in the event radioactive contamination was identified (Woodward Clyde 1990).

At the request of Rockwell International, the Colorado Department of Health (CDH) inspected the landfill in 1978 and 1979. CDH stated that the landfill appeared to comply with state and federal minimum standards and department regulations. In addition, CDH determined that a certificate of designation for landfilling of waste was not required (Woodward Clyde 1990).

Although originally planned as a sanitary landfill, routine operations at the Present Landfill included disposal of materials containing polychlorinated biphenyls (PCBs) (i.e., used fluorescent light ballast); combustible materials contaminated with small amounts of beryllium particulate matter; containers partially filled with paints, solvents, and foam polymers; kimwipes and rags contaminated with paints, solvents and foam polymers; used filters; and metal cuttings and shavings (documented as primarily stainless steel). Wastes with hazardous constituents ceased to be disposed of in the landfill by the fall of 1986, by tightening of administrative procedures and the implementation of findings of the Waste Stream Identification and Characterization Reports (produced by Weston in 1986 and 1987) (Woodward Clyde 1990). In addition, sludge from the Building 995 sanitary waste treatment plant was routinely disposed at the Present Landfill from August 1968 through May 1970 and may have contained low levels of plutonium and depleted uranium.

Beginning in 1985, asbestos-containing material (ACM) was disposed in designated 10-foot-deep pits located east of the Present Landfill. The ACM was wrapped in heavy plastic bags, placed in the pit, and covered with soil. Site records indicate that disposal of ACM continued until April 1990. Nonroutine wastes disposed in the Present Landfill included tear gas powder; a tank containing Mercaptan™ (an odor additive to natural gas); a drum of solidified polystyrene resin used in fiberglassing operations; soil contaminated with approximately 700 gallons of diesel fuel; wood contaminated with chromium and aluminum oxide; unknown chemicals; and unknown reactive chemical residues.

The Present Landfill remained in operation until March 1998, at which time it was placed in a contingent closure status and seeded to stabilize soil and control erosion. The Present Landfill occupies an area of approximately 20 acres. Waste material is generally thinnest along the boundaries and thickest along the east-west axis of the landfill. Thicknesses range from less than 1 foot to approximately 40 feet near the eastern face of the landfill.

Leachate has been forming at the Present Landfill since waste operations began in 1968. Present Landfill leachate is the liquid resulting from the infiltration of precipitation through the landfill.

A seep exists at the east end of the landfill (known as the Present Landfill seep), as a result of infiltration of precipitation and the migration of groundwater through the landfill. The volume of Present Landfill leachate within the landfill varies as the potentiometric surface fluctuates in response to infiltration of precipitation through the soil cover. The volume of groundwater migrating through the landfill also varies as the potentiometric surface fluctuates.

2.2 Previous Response Actions

A number of response actions were taken when tritium and strontium were detected in contaminated groundwater draining from the eastern face of the Present Landfill in 1973. These actions include the following:

- In September 1973, tritium and strontium 89/90 were detected in leachate draining from the Present Landfill. As a result, approximately 57 monitoring wells were installed directly into the landfill waste and immediately below the waste materials, and a sampling program was initiated to determine the location of the source. The highest measured concentrations in groundwater were 301,609 picocuries per liter (pCi/L) of tritium and 7 pCi/L of strontium.[6] By 1980, tritium concentrations had decreased to approximately 500 pCi/L. Monitoring for tritium in surface water and groundwater ended in 1981 for this response action, when measured levels had fallen to background.

- A radiation monitoring program was established in 1973 to prevent disposal of radioactive materials into the landfill.

- A surface water diversion ditch was constructed in 1974 around the perimeter of the landfill to divert surface water runoff and reduce the infiltration of surface water into the landfill (Figure 2). No waste disposal is known to have occurred outside the surface water diversion ditch.

- A groundwater collection system was installed in 1974 to intercept and divert groundwater flow around the landfill (Figure 2). The collection system was also designed to collect water seeping from the eastern edge of the landfill for discharge to the West Landfill Pond.

- From October 1974 to January 1975, temporary berms were upgraded to permanent pond embankments. The West Landfill Pond was used to impound leachate and the East Landfill Pond (Figure 2) was created to provide backup for overflow from the West Landfill Pond. The East Landfill Pond was also used to collect intercepted groundwater as needed.

  Surface water control/diversion/interceptor ditches were constructed around perimeter of the landfill (north, west, and south) to intercept surface water runoff flowing toward the

[6] Background levels were considered to be approximately 1 to 25 pCi/L for strontium in water, based upon water samples collected at this time period from Rock Creek (Woodward Clyde 1990). Strontium was analyzed in the landfill ponds, drainages, and groundwater intercept system, and generally found at background levels at this time (Woodward Clyde 1990). The half-life of strontium 89/90 is approximately 29 years, the RFCA groundwater Tier I AL is 85.2 pCi/L and the RFCA surface water AL is 8 pCi/L.

landfill. The ditches acted to divert surface water away from the landfill to reduce infiltration of surface water into the landfill.

A groundwater intercept system was installed around the perimeter of the landfill (north, west and south; inside the surface water interceptor ditches) to divert uncontaminated groundwater around the landfill. The system was constructed by excavating around the perimeter of the landfill to depths of 10 to 25 feet. The trench excavation for the systems was 24 feet wide at the base. The groundwater collection system was installed on the side of the trench away from the landfill waste. A sand/gravel blanket along the trench face intercepted groundwater, which drained to perforated pipe installed in the bottom of the trench. Intercepted groundwater was discharged to the landfill ponds or to surface water drainages by a series of valves.

- In 1975, water volumes were controlled by periodic spray evaporation to areas located on the north and south banks of the East Landfill Pond (IHSSs 167.2 and 167.3).
- Between 1977 and 1981, the West Landfill Pond was buried as the landfill was expanded. Later, a more permanent embankment was constructed for the East Landfill Pond, consisting of an engineered dam with a spillway designed to retain the majority of the water in the channel. To reduce seepage from the pond, a low-permeability clay core was constructed within the embankment, keyed to bedrock. The East Landfill Pond covers approximately 2.5 acres and has a capacity of approximately 7.5 million gallons. The East Landfill Pond water levels are controlled to prevent overflow into the spillway draining to the No Name Gulch drainage by pumping water to Pond A-3, via the Pond A-1 bypass, for eventual discharge from the Site.
- When the West Landfill Pond was covered in 1981, the existing collection system was extended to discharge into the East Landfill Pond, and optimally into the No Name Gulch drainage.
- Two 900-foot soil-bentonite slurry walls were constructed near the eastern end of the Present Landfill in 1982 to prevent groundwater migration into the expanded landfill area. The slurry walls were tied into the north and south arms of the groundwater intercept system.
- Beginning in 1986, the U.S. Department of Energy (DOE) began a Comprehensive Environmental Assessment and Response Program (CEARP) to investigate groundwater contamination at the Site. This included the installation of groundwater monitoring wells at the Present Landfill, which were monitored for the CERCLA Hazardous Substance List (HSL) volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, major ions, and radionuclides (including tritium). Also in 1986, pursuant to the 1986 Compliance Order and CERCLA Agreement, DOE began an extensive environmental investigation for the entire site. (A summary of the groundwater monitoring activities beginning in 1986 is provided in Appendix b.)

- On January 22, 1991, DOE, EPA, and CDH entered into an Interagency Agreement (IAG) replacing the 1986 Agreement. This agreement did not change or impact the groundwater monitoring requirements at the Present Landfill.

- A Phase I RFI/RI was conducted in 1992 and 1993 to characterize the site features at the Present Landfill, and to make preliminary determinations of the sources of contamination and the nature and extent of contamination. The Phase II RFI/RI was conducted in 1994 and 1995 to further define the nature and extent of contamination and support the development of an IM/IRA. A Phase I IM/IRA and Closure Plan document was prepared in 1996 (DOE 1996), concurrent with negotiations of RFCA. Attachment 4 to RFCA contained a prioritized list of remedial actions for the Site, which placed the Present Landfill at number 18 of the top 50 areas requiring remediation. As a result, the 1996 Draft IM/IRA was abandoned, and resources and funding were reallocated to other areas ranking higher on the list.

- Four gas vents were installed in the Present Landfill in 1994 to release gases generated by microbial degradation of organic waste. The composition, quantity, and generation rates of the gases depend on factors such as waste quantity and composition, waste placement characteristics, landfill thickness, moisture content, and oxygen levels. Carbon dioxide is the principal gas generated during the early stages of waste burial, as the waste undergoes aerobic microbial degradation. As oxygen is depleted, anaerobic microbial degradation produces methane and carbon dioxide. In 1994, carbon dioxide and methane were the primary gases produced.

- Spray evaporation operations were discontinued in 1994. (Since this time, the pond level has been controlled by pumping the water to Pond A-3, via the Pond A-1 bypass, for eventual discharge from the Site.)

- In May 1995, a well evaluation project was undertaken at Rocky Flats to continue the assessment of the Sitewide groundwater monitoring network, in light of reduced budgets and the cessation of many RI/FS activities. A core working group of stakeholders, composed of representatives from CDPHE, EPA, DOE, and the Kaiser-Hill Company, L.L. C. (K-H) team, held regular meetings to evaluate and negotiate a technically defensible monitoring network that would maintain compliance with current agreements and provide surveillance of known contaminant migration pathways. The underlying assumption in the network design was that groundwater monitoring should be conducted to assess the potential impact to surface water, which has been accepted by the agencies as the sole pathway for contaminated water to leave Rocky Flats.

- A passive seep interception and treatment system was constructed in 1996 to collect Present Landfill seep water flowing from the eastern end of Present Landfill (Figure 2). The original system design provided for the collection and storage of the Present Landfill seep water in polyethylene tanks, which would be pumped to a tanker truck for transport to a designated treatment facility. Prior to construction of this system, the original PAM was modified to incorporate a passive treatment system using granular activated carbon (GAC) to remove organic chemical constituents, including VOCs and SVOCs (DOE

1995). The PAM was modified once more before construction to change the configuration of the GAC and add filters to the system (DOE 1996).

- RFCA was adopted on July 19, 1996, which replaced the IAG as the environmental cleanup agreement for RFETS. The RFETS Action Levels and Standards Framework for Surface Water, Groundwater and Soils (ALF) attachment to RFCA contains specific requirements for environmental monitoring and reporting, and it sets Action Levels (ALs) for contaminant concentrations in groundwater and other media. The results from the 1995 well evaluation project were aligned with the new RFETS mission and RFCA

After treatment, water is collected in the East Landfill Pond, and then periodically pumped to Pond A-3.

- The Actinide Migration Evaluation (AME) group performed an investigation of historical groundwater uranium data studies in 2003.

of waste material ranges from less than 1 foot to approximately 40 feet near the eastern face of the landfill, which coincides with the deepest portion of the original drainage. Waste delivered to the landfill was spread across the work area, compacted, and c

Shale and Fox Hills Sandstone underlie the Site, with the latter exposed in quarries along the western boundary. The Cretaceous Laramie and Arapahoe Formations are exposed at the surface or underlie the Site. The Quaternary Rocky Flats Alluvium unconformably overlies the

Colluvium is material that has been deposited by slope wash, soil creep, and landslides and is derived from alluvial material and bedrock of the Arapahoe and Laramie Formations. Colluvium covers the hillsides between the pediment on which the Rocky Fl

2.5.3 Distribution of Geologic Units

Geologic units beneath the Present Landfill consist of a thin covering of colluvium on the hillsides and valley-fill alluvium in the No Name Gulch drainage. Both are underlain by the Laramie Formation. The colluvium consists of clays and silts. The valley-fill alluvium is composed of gravelly, clayey sand. Geologic units on the groundwater divides adjacent to the landfill consist of Rocky Flats Alluvium, underlain by the undifferentiated Arapahoe and Laramie Formations. The Rocky Flats Alluvium consists of clayey gravels and sands. Lithologies of the undifferentiated Arapahoe and Laramie Formations are typically limited to claystones and siltstones.

Fine-grained sandstone subcrops beneath the alluvium, downgradient of the East Landfill Pond dam. This sandstone pinches out approximately 500 feet downstream. Shallow sandstones, present within 15 feet of the contact between the alluvium and bedrock, were encountered in wells located within the landfill on the southern side and on the southwestern shore of the East Landfill Pond. Based on a 2-degree regional dip, it is expected these shallow sandstones do not subcrop in the area of the Present Landfill and are not preferential pathways for migration of contaminants.

Other Laramie Formation sandstones are present at depths where there is no hydraulic connection with surficial deposits. Laramie Formation sandstones were identified near the East Landfill Pond, within the landfill, and downgradient of the dam, in the No Name Gulch drainage. Laramie Formation sandstones were also identified at depths of 50 to 125 feet below ground surface.

2.5.4 East Landfill Pond Sediments

Sediments have been accumulating in the East Landfill Pond since its construction in 1974. The sources of contaminant loading to the East Landfill Pond sediments include the Present Landfill seep water and surface water runoff from surrounding slopes. Results from sampling events performed during the Phase I RFI/RI indicate the sediments consist of clay, silt, and organic matter, ranging from 0.5- to 0.8-foot thick. The upper 0.2 to 0.5 foot of sediments consist of black silt and clay, with very fine roots occurring in either thin mats or scattered throughout the core. No bedding or lamination was visible. The remaining 0.3 to 0.4 foot of core consisted of very dark gray clay with some silt. Very fine roots were observed, decreasing with depth. The East Landfill Pond sediments are underlain by olive-gray claystone of the Laramie Formation.

2.5.5 Hydrologic Setting

The Present Landfill is located within the Walnut Creek Drainage, which consists of three tributaries: The No Name Gulch drainage, North Walnut Creek, and South Walnut Creek. These tributaries drain the central and northern area of RFETS.

A surface water diversion ditch was constructed around the perimeter of the Present Landfill in 1974 to divert surface water runoff around the landfill and reduce infiltration of surface water into the landfill. On the northern side of the landfill, the ditch runs under a perimeter road through a small culvert and east into a small, natural drainage that eventually joins the No Name Gulch drainage below the East Landfill Pond dam. On the southern side of the landfill, the ditch

runs east above the East Landfill Pond and drops into the No Name Gulch drainage below the dam (Figure 2).

The East Landfill Pond covers approximately 2.5 acres. Pond water levels are controlled to prevent overflow into the spillway draining to the No Name Gulch drainage. Recharge to the pond occurs from direct precipitation, groundwater discharge, Present Landfill seep flow, and surface water runoff from the surrounding hillslopes. The majority of flow into the East Landfill Pond comes from direct runoff and Present Landfill seep flow, while groundwater discharge is likely limited because of the relatively low hydraulic conductivity of the underlying weathered bedrock. The groundwater intercept system was also designed to discharge into the East Landfill Pond; however, data are unavailable to indicate whether this occurs. (Additional information is provided in the integrated hydrologic flow model [Appendix C], and in Section 2.5.7.3 regarding the operation of the landfill trench system.) The East Landfill Pond discharge occurs by natural evaporation, seepage downward into weathered bedrock, seepage through the clay core of the dam, and water transfers to Pond A-3.

2.5.6 Hydrogeologic Setting

In the area of the Present Landfill, groundwater flows predominantly within the UHSU. The UHSU is composed of materials that include the Rocky Flats Alluvium, colluvium, Valley Fill Alluvium, and weathered claystone bedrock. Unweathered bedrock claystones are included as part of the LHSU. The thickness of the weathered bedrock material varies considerably in the vicinity of the landfill, ranging from approximately 4 to 35 feet.

The mean hydraulic conductivity values for the landfill waste, colluvium, Rocky Flats Alluvium, and Valley Fill Alluvium range from 1×10^{-4} centimeter per second (cm/sec) to 1×10^{-5} cm/sec. The mean hydraulic conductivity value for the underlying weathered claystone of the Laramie Formation ranges from 1×10^{-6} to 1×10^{-7} cm/sec. Unconfined storage coefficients (specific yield) are relatively low for the UHSU material, estimated to be approximately 0.1 based on the Site-Wide Water Balance (SWWB) modeling (K-H 2002a).

Most of the monitoring wells within the landfill have been abandoned in recent years in preparation of closure of the facility. Historically, within the Present Landfill, groundwater was encountered at approximately 20 feet at the western end, 16 feet in the middle, and 33 feet at the eastern end. The saturated thickness of UHSU deposits varies widely across the landfill, with the thickest sections found in the Rocky Flats Alluvium at the western end, and the thinnest sections found in colluvial and valley-fill deposits east of the East Landfill Pond and in the Rocky Flats Alluvium along the south divide. In the past, the average depth to groundwater ranged from 5 to 15 feet in surficial deposits around the landfill.

Historically, water levels in the surficial deposits of the UHSU exhibit seasonal variations of as much as 10 feet. The elevation of the water table is generally lowest in late winter and early spring and highest during June and July. Available water level data indicate that a recharge event generally occurs each year during the spring. Groundwater elevations in UHSU weathered bedrock have shown seasonal variations of as much as 15 feet.

Within the landfill wastes, groundwater generally flows toward the center of the landfill, and then east towards the East Landfill Pond, although hydrologic modeling performed by the

RFETS has predicted that, within the waste, groundwater can flow locally toward the landfill drain system (laterally outward) and then to the former western pond locations, where it then flows eastward toward the Present Landfill seep area and discharges to the surface. At the Present Landfill seep location, groundwater is forced out to the ground surface because of the lower saturated hydraulic conductivity of the shallow underlying weathered bedrock. Groundwater also concentrates at this location because it is located along the centerline of a former streambed (No Name Gulch drainage), where northern and southern hillslope groundwater flow would have been directed. Currently, the model suggests saturated zone flows within the UHSU and waste material upgradient of the Present Landfill seep discharge to the ground surface at this location.

Outside the landfill, groundwater flow directions generally mimic surface topography and the weathered bedrock surface. The Present Landfill seep discharge is first treated and then flows mostly as surface flow over the ground surface, until it mixes with the East Landfill Pond water and either evaporates or is pumped to Pond A-3. Some of the East Landfill Pond water likely percolates downward into underlying bedrock materials and laterally through the dam, although, these flows are likely small due to the low permeabilities. The groundwater flow from and beneath the landfill dam then flows within shallow alluvium within No Name Gulch drainage, where it flows until it is discharged as evapotranspiration or as surface flow in No Name Gulch drainage. The No Name Gulch drainage rarely flows immediately downgradient of the dam (once every three years[7]).

As stated above, current water level data from within the landfill are unavailable. The historic vertical hydraulic gradients that were calculated for well pairs within the landfill generally indicate a net downward (recharging) component of flow, with values ranging from 0.022 to 1.099 feet per foot (ft/ft). At one well pair situated within the center of the landfill, groundwater had a slight upward (discharging) vertical gradient that ranged from 0.020 to 0.026 ft/ft. Historical data from all the well pairs indicate that vertical hydraulic gradients generally remained constant over time. A vertical hydraulic gradient for current downgradient well pair 4087/B206989, calculated in July 2002, indicates a downward component of flow at 0.686 ft/ft.

2.5.7 Conceptual and Numeric Integrated Hydrologic Flow Model

An integrated hydrologic model, similar to that developed for the SWWB (K-H 2002a), was developed for the Present Landfill system. Its development and application is presented in Appendix C. The purpose of this model was to assess both surface and subsurface flow conditions to support analysis of water quality data (Section 2.6). Specifically, overland flows are dynamically coupled to unsaturated and saturated zone flows. Consequently, the integrated model developed for the landfill is capable of simulating ponding and subsequent surface runoff and infiltration into the subsurface. The model also provides a physically realistic means of simulating the spatial and temporal distribution of recharge and evapotranspiration over both waste material and surrounding existing soil. This system response is essential to simulating groundwater flows within the waste and surrounding areas.

Information for the Present Landfill modeling project was derived principally from available reports in the Environmental Restoration (ER) library, Sitewide well data, and data collected for

[7] Personnel communication G. Squibb, 2003.

the SWWB (K-H 2002a). Landfill-related hydrogeologic data and history were evaluated first and used to develop an integrated conceptual flow model for the landfill. A numeric model was then constructed using the integrated flow code MIKE SHE, in an approach similar to that used in developing the regional SWWB model (K-H 2002a). Details of the integrated numeric design of the MIKE SHE flow model for the Present Landfill are described in detail in Appendix C.

The integrated hydrologic model focused on the Present Landfill and surrounding areas. Geologic surfaces for the top and bottom of the weathered bedrock zone were interpreted based on the most complete compilation of historical borehole information from the landfill area to date. The extent and thickness of the waste material from previous work were incorporated into the model. In addition, key landfill control structures, such as the groundwater interception system (GWIS), clay barrier, landfill drain, and slurry walls, were also included in the model design. Published vegetation distributions for the 1993 to mid-1995 and 2000/2001 time periods (K-H 2002a) were converted into hydrologically significant categories and used in the model for calibration and model validation. The REF-ET Program (Allen 2000) was used to calculate the PET using the FAO56 version of the standard Penman-Monteith equation for 1993 and 1994 Site climatic data.

2.5.7.1 Conceptual Flow Model

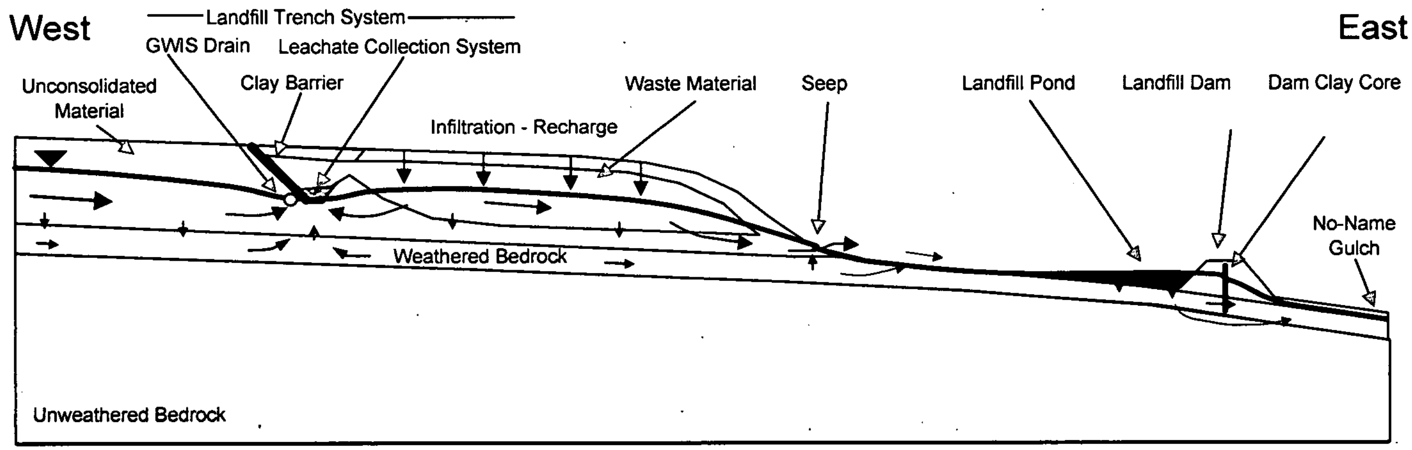
Precipitation in the form of rain or snow intercepts the ground surface and begins to infiltrate. If storm intensity and duration are sufficient, ponding may occur, although under typical conditions this generally does not occur (not even once per year). Ponding over the western portion of the landfill would then lead to surface runoff, which would be diverted around the landfill and discharged to the No Name Gulch drainage below the East Landfill Pond dam. Ponding over the eastern part of the landfill is directed toward the East Landfill Pond.

Shallow surface infiltration rates of precipitation to the unsaturated zone are relatively high, given the high effective saturated hydraulic conductivities of surface soil. Although only a portion of the total infiltrated water actually recharges the saturated zone (or groundwater table), recharge rates are relatively high. Generally rates are several inches, as reported in the recent SWWB modeling (K-H 2002a).

Although groundwater flows regionally from west to east at RFETS, locally it closely follows surface topography and the weathered bedrock surface. Near the Present Landfill, groundwater flows from hilltop ridges to nearby streams. Groundwater is also redirected locally toward such features as the landfill trench system, which includes the GWIS, landfill drain system, and clay barrier, as shown on Figure 3. Groundwater flows vertically downward over the entire system, except as shown near the Present Landfill seep and downgradient stream area (i.e., No Name Gulch drainage). Groundwater flows are greater in the unconsolidated material and waste than in the weathered bedrock due to higher average hydraulic conductivities. Flows in the unweathered bedrock are much lower than in the weathered bedrock because of even lower hydraulic conductivities.

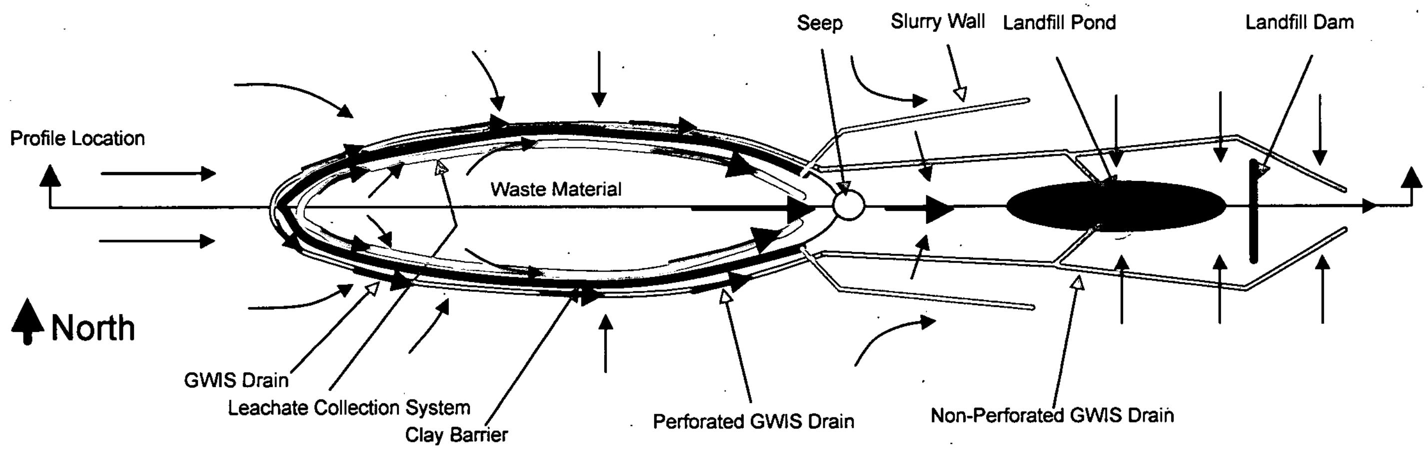
Figure 3
Conceptual Flow Model for the Present Landfill

Present Landfil Profile (Looking North)



Note: Arrows depict groundwater, unsaturated zone, or overland flow directions and magnitudes

Present Landfil Plan View and Profile Location



Note: Arrows depict groundwater flow directions and are sized to approximate flow magnitudes

The landfill trench system does not fully extend to weathered bedrock along its entire length, as shown on Figure 3. Despite this, groundwater levels are still controlled by the barrier system. The clay barrier prevents the Present Landfill leachate from entering the external GWIS drain, or external water from entering the landfill drain system. Groundwater beneath the waste in unconsolidated material and weathered bedrock flows laterally toward the Present Landfill seep as shown. Near the Present Landfill seep, groundwater inflows (toward the Present Landfill seep) from the northern and southern hillslope areas are limited due to the two east-west trending slurry walls that extend into the weathered bedrock. The slurry walls, therefore, act to additionally focus upgradient saturated zone flows toward the Present Landfill seep area. The Present Landfill seep flow varies throughout the year and has been estimated at 1 to 7 gallons per minute (gpm).

Water flows through the groundwater system and primarily discharges through seeps. There is one primary seep at the Present Landfill located at the base on the eastern face of the landfill (Figure 2) (known as the Present Landfill seep). A second intermittent seep area exists north of SW097 on the hillside below the north asbestos disposal area (Figure 2). This seep only activates during significant precipitation events, and its flow is not monitored.

At the Present Landfill seep, groundwater discharges to the surface from both the unconsolidated material and the underlying weathered bedrock. All saturated zone flow upgradient of the Present Landfill seep is conceptualized as discharging at the surface at, or immediately downgradient of, the Present Landfill seep. The Present Landfill seep discharge then flows into the East Landfill Pond after being treated. From the East Landfill Pond, groundwater flows beneath (within the weathered bedrock) and through the dam at a slow rate because of low associated permeabilities. Groundwater from the East Landfill Pond is largely constrained downstream of the dam to flow within the valley fill alluvium, or weathered bedrock. From here it mixes with lateral inflows from the northern and southern hillslope colluvium and landslide deposits and becomes subject to loss as evapotranspiration. The SWWB modeling showed that most of this water is subject to loss locally by means of evapotranspiration, while only a small portion is subject to discharge as surface water flow, which occurs infrequently (once every three years as previously reported).

2.5.7.2 Integrated Flow Model

The model was calibrated using data for the 1993 to mid-1995 period. This period was chosen because it was the latest historical period of water level measurements within the Present Landfill boundary, and spring 1995 was an extremely wet period with substantial system response. Model calibration focused on matching average 1994 groundwater levels, timing, and magnitude of system response at wells, and the Present Landfill seep flow at SW097.

Following model calibration, a sensitivity analysis was conducted to establish which model parameters dominate the hydrologic flow response for the Present Landfill system. Model sensitivity to hydraulic conductivity, leakage coefficients, landfill material properties, and East Landfill Pond water levels was evaluated for Present Landfill seep flow, modeled GWIS discharge, and groundwater levels.

The model was run for a validation period of Water Year (WY)2000 with the topography modified to the current land surface at the landfill and the vegetation coverage revised to reflect that the landfill area had been reseeded in 1998. The model was found to be sensitive to the WY2000 climate change and vegetation changes but simulates system response reasonably well.

A hypothetical scenario was run to evaluate the possible impacts of a potential closure scenario for the Present Landfill. In this scenario, the landfill area cover material was assumed to be 2 feet thick and fully vegetated. Results of this simulation were then compared to simulated landfill conditions without the additional cover and less established vegetation. These simulations were run for the calibration model climate years of 1993 and 1994. An additional run was performed with the wet year precipitation from the SWWB (K-H 2002a) to evaluate impacts of a wetter climate on the landfill system.

2.5.7.3 Key Modeling Findings

The primary purpose of developing a flow model was to better understand the past, current and possible future integrated hydrologic conditions to support a detailed water quality analysis in the Present Landfill area. The amount of modeling output generated through development and application of the integrated Present Landfill model is substantial and provides new insight into the integrated and dynamic hydrologic behavior within and surrounding the Present Landfill area. Key findings include the following:

- The calibrated integrated model reproduces observed annual Present Landfill seep (SW097) flow location and discharge and key spatial and temporal well water level response to annual recharge events and evapotranspiration reasonably well.

- The model shows that observed Present Landfill seep flow and water level data are best simulated when the landfill trench system (i.e., GWIS, clay barrier, and landfill drain) is assumed to be functional.

  A sensitivity analysis was performed to evaluate how the system responded without the external GWIS drain. Results showed that hydraulic heads, or groundwater levels, increased only slightly external to the landfill GWIS but still reproduced observed heads reasonably well without the external drain. In addition, the seep discharge also increased as a result of the increased gradient in toward the internal GWIS landfill drain, which preferentially drains to the former western pond area and then to the seep. Either way, simulated heads, flow paths, and seep discharge rates were similar for both cases. Therefore, the model results were generally not sensitive to whether this external drain is operational. Ultimately, the external GWIS drain may only distribute groundwater along the drain, extracting groundwater from higher water level areas and infiltrating groundwater where levels are lower. Because of this, groundwater may never discharge into the nonperforated portion of the pipe.

- Modeling shows that groundwater interior to the trench system flows outward to the landfill drain and is then routed toward the former West Landfill Pond area. Exterior groundwater is intercepted by the GWIS and directed away to either the East Landfill Pond or the No Name Gulch drainage. The clay barrier prevents exterior and interior flows from mixing.

- The model shows that water in the landfill waste material is derived mostly from direct recharge of precipitation over the waste material (greater than 90 percent), rather than lateral or vertical groundwater inflow.

  The basis for 90 percent infiltration versus 10 percent lateral groundwater inflow rather than previously reported 60 percent infiltration and 40 percent lateral groundwater inflow is due to differences in how the landfill area was modeled. Previous modeling only considered groundwater flow (i.e., only a groundwater model), while recent results are derived through integrated modeling that considers the coupled behavior of overland flow, unsaturated zone flow, and saturated zone flow. As a result, more information is used to calibrate the integrated model. For example, short-term groundwater level fluctuations over multiple years and seep discharge (and semiquantitative observations that overland flow is limited) are used to calibrate the integrated model. This model also simulates the transient behavior of groundwater flow conditions, while former groundwater modeling assumed steady-state conditions and assumed the spatial and temporal distribution of groundwater recharge, a critical factor in simulated groundwater flows within and surrounding the Present Landfill. Former modeling had no basis for calculating the recharge and, as such, could not calculate the infiltration versus lateral groundwater inflow accurately. The integrated model calculates the complex spatial and temporal recharge to the groundwater system within and external to the landfill waste area by reproducing key groundwater level fluctuation characteristics such as timing of major annual recharge events, approximate magnitude of groundwater level adjustments to these recharge events, and subsequent drainage response to these perturbations. The integrated model results showed clear differences between landfill waste wells and those external to the waste in terms of these characteristics. As such, the integrated model produces more realistic and accurate results.

- The Present Landfill seep flow at SW097 is most sensitive to the hydraulic conductivity of the waste material and other unconsolidated material, the hydraulic conductivity of the landfill drainage material, and the hydraulic conductivity of the weathered bedrock. Modeling results show subsurface water in the footprint of the landfill system, upgradient of the Present Landfill seep, discharging to the Present Landfill seep, or the East Landfill Pond, regardless of whether the landfill trench system is functional.

- In a hypothetical scenario where additional cover material and fully developed vegetation are assumed, modeled seep flow is reduced by approximately 10 percent compared to the baseline scenario (i.e., current landfill configuration and WY2000 climate). In a comparably wet year, seep flow increased by approximately 10 percent, while mean modeled groundwater elevations in the landfill increased by 0.1 meter.

- In another hypothetical scenario where recharge within the landfill clay barrier and slurry walls is reduced by approximately 90 percent, modeled seep flow decreases approximately 25 percent over a 2.5-year period. This is mostly from a decrease in saturated zone storage. Mean modeled groundwater elevations in the landfill decrease by 0.5 meter. Lateral subsurface flow into the landfill area is still small, but increases as a result of increased gradients across the landfill trench.

2.5.8 Meteorology and Air Quality

RFETS is located in the southern Rocky Mountains and has a continental, semiarid climate. The region is noted for large seasonal temperature variations, occasional dramatic short-term temperature changes, and strong, gusty winds that reach 75 miles per hour (mph) annually and 100 mph every three to four years. Mean annual precipitation is approximately 15.5 inches, with approximately one-half occurring as snow.

Although air quality is generally better at RFETS than in the urbanized portion of the Denver Metropolitan Area, the Site is continuously and extensively monitored for air pollutants. The Site is located within the Metropolitan Denver Intrastate Air Quality Control Region No. 36 (Region).

Radiological air emissions both on and off site are largely unrelated to Site operations. Most radiation is naturally occurring background radiation from sources such as radon. The annual background dose for Denver area residents is approximately 418 millirems (mrem). Radioactive emissions from the Site are principally from contaminated soil, with an annual dose for the nearest, most impacted off-site resident of approximately 0.1 mrem. Facilities with potential radionuclide emissions are continuously monitored to ensure emissions are properly controlled and comply with applicable regulations.

Additional details concerning meteorology, air quality, monitoring, and air emission controls at the Site can be found in the Rocky Flats Cumulative Impacts Document (CID) (DOE 1997), and the 2000 CID Update Report (DOE 2001).

2.5.9 Ecological Setting

The BZ surrounding the IA of the Rocky Flats site generally supports a wide variety of native plant communities and wildlife. However, the areas in and around the Present Landfill have been subject to extensive physical disturbance associated with the landfill operations and construction of the East Landfill Pond and groundwater intercept system.

2.5.9.1 Vegetation

The Rocky Flats site is located between Boulder and Golden, Colorado, in a transitional zone known as the Colorado Piedmont. The Colorado Piedmont is an area of dissected topography containing floristic features from the Great Plains prairie and the Rocky Mountain foothills. The present-day vegetation of Rocky Flats is dominated by xeric tallgrass prairie, mesic mixed grassland, wetlands, and plains cottonwood riparian woodland/shrubland communities. Typical species on the xeric tallgrass prairie that occurs on the pediment tops are big bluestem, little bluestem, mountain muhly, Canada bluegrass, needle and thread grass, and a variety of other grass and forb species. Grasses prevalent on mesic mixed grassland sites include western wheatgrass, blue grama, sideoats grama, green needle grass, Canada bluegrass, Kentucky bluegrass, and prairie junegrass. Common upland forbs include hairy gold-aster, white sage, western ragweed, broom snakeweed, and scurfpea. Wetland areas are dominated by rushes, bulrushes, sedges, and cattails, while along the streams willows, leadplant (wild indigo), and plains cottonwoods are prevalent. Various weedy species such as cheatgrass, Japanese brome, diffuse knapweed, dalmatian toadflax, musk thistle, common mullein, St. Johns Wort, and a host of others are common on upland sites. In the wetter areas, Canada thistle is common. Reclaimed sites are dominated by smooth brome, crested wheatgrass, and intermediate wheatgrass. Specific plant communities present in the Present Landfill area are described in the following subsections.

2.5.9.2 Xeric Tallgrass Prairie

The xeric tallgrass prairie is found on the pediment tops adjacent to the Present Landfill where disturbance has not taken place. Based on vegetation studies from the BZ at the Site, common species in this community include big bluestem, little bluestem, Canada bluegrass, mountain muhly, and Porter's aster, in addition to somewhat less common species such as blue grama, hairy grama, junegrass, indian grass, sun sedge, and various other forb species. At most locations around the Present Landfill, this community type has been degraded by invasions of diffuse knapweed.

2.5.9.3 Mesic Mixed Grassland

The mesic mixed grassland occurs on the hillsides in the vicinity of the Present Landfill and across the Site. It is the predominant plant community on the hillsides in No Name Gulch. Common grasses include western wheatgrass, blue grama, Sideoats grama, Canada bluegrass, and prairie junegrass. At some locations, Kentucky bluegrass, big bluestem, little bluestem, crested wheatgrass, and needle-and-thread are also present. Forbs include scurfpea, various species of sage and asters, and other less frequent wildflower species. Prickly pear cactus are also common throughout the area.

2.5.9.4 Disturbed Community

Some locations around the Present Landfill are dominated by a disturbed community classification. This community classification occurs where the native soil and vegetation have been disturbed or altered. At these locations, early successional, weedy species such as diffuse knapweed, St. John's Wort, musk thistle, and other annual/biennial species are common. This low-quality habitat provides little value for wildlife in the area.

2.5.9.5 Landfill Surface

In 1998, after closure of the landfill, the landfill surface itself was reseeded with a native seed mixture to establish a vegetative cover. Monitoring conducted in 2001 revealed the landfill surface was dominated largely by blue grama, western wheatgrass, buffalo grass, and Sideoats grama (all seeded species). Some bare areas were present; however, the vegetation appeared to be filling in the spaces between the plants (K-H 2002b).

2.5.9.6 Wetlands

Tall and short marsh wetland communities occur in the area around the East Landfill Pond. A total of 3.1 acres of wetlands, as delineated by the U.S. Army Corps of Engineers (1994), are located in the immediate vicinity of the Present Landfill, including 0.8 acre of palustrine emergent wetlands at the margins of the East Landfill Pond, and 2.3 acres of lacustrine wetlands associated with the pond bottom and open-water habitat combined. The 0.8 acre of palustrine wetlands represents approximately 0.5 percent of the palustrine and riverine wetlands at RFETS. The East Landfill Pond represents approximately five percent of the Site's open water habitat, and approximately 6 percent of the shoreline habitat. In No Name Gulch, a narrow ribbon of wetland occurs in the bottom of the drainage. The wetland types along No Name Gulch include palustrine emergent (seasonally and temporarily flooded), a small palustrine emergent impoundment, and some palustrine scrub-shrub (seasonally flooded). Most of the time, No Name Gulch is dry.

2.5.9.7 Wildlife

The Rocky Flats Site supports a wide variety of wildlife: large and small mammals, birds, reptiles, amphibians, aquatic macroinvertebrates, and fish. This relatively rich animal community is, in part, due to the isolation of the Site from the increasing human activity in the surrounding areas. Few specific wildlife surveys have been conducted at the Present Landfill, except where specified below. Therefore, the information presented is based on what has been found in similar habitats elsewhere at the Site.

The most abundant large mammal is the mule deer; population estimates vary annually between 100 and 150 animals. White-tailed deer have also been infrequently observed. Large carnivores present at Rocky Flats include coyotes, red foxes, gray foxes, striped skunks, long-tailed weasels, badgers, bobcats, and raccoons. Eastern cottontails and white-tailed jack rabbits are also present. Black-tailed prairie dogs occur in upland areas in the eastern portions of the BZ. Some ponds support muskrats.

The Rocky Flats Environmental Impact Statement (EIS) (DOE 1980) reported that eight species of small mammals were captured during a live-trapping program in 1975: harvest mice, deer mice, meadow voles, thirteen-lined ground squirrels, hispid pocket mice, silky pocket mice, pocket gophers, and house mice. A more recent study has documented the occurrence of six additional species: Mexican woodrats, plains and western harvest mice, prairie voles, and both western and meadow jumping mice (DOE 1993c). Small mammal trapping conducted during 1995 and 1996 around the Present Landfill pond documented western harvest mice, deer mice, meadow voles, thirteen-lined ground squirrels, prairie voles, and house mice (K-H 1996). The Preble's meadow jumping mouse, a federally listed threatened species, was not documented in the vicinity of the Present Landfill. Trapping and telemetry work conducted in Walnut Creek in 1999 continued to document the absence of Preble's mice in the vicinity of the landfill area (K-H 2000b).

The varied habitats at the Rocky Flats site support many bird species. Common grassland birds include western meadowlarks, horned larks, vesper sparrows, grasshopper sparrows, western kingbirds, and eastern kingbirds. Riparian areas dominated by cottonwoods support black-billed magpies, northern orioles, yellow warblers, warbling vireos, American robins, indigo buntings, blue grosbeaks, and lesser and American goldfinches. MacGillivray's warblers, yellow-breasted chats, black-headed grosbeaks, green-tailed and rufous-sided towhees, and lazuli buntings occur in other wooded areas. Marshlands support song sparrows, common yellowthroats, red-winged blackbirds, common snipe, and sora rails. Common birds of prey occurring at the Rocky Flats site include American kestrels, northern harriers, red-tailed hawks, Swainsons's hawks, great horned owls, and long-eared owls. Occasionally, golden eagles, prairie falcons, rough-legged hawks, and short-eared owls are observed. Bald eagles are noted visitors during the winter. Open-water areas, including ponds and intermittent creeks, attract water birds such as mallards, gadwall, green-winged teal, blue-winged teal, pied billed grebes, spotted sandpipers, killdeer, great blue herons, black-crowned night-herons, and double-crested cormorants. Migrating sandhill cranes have also been observed at the Site.

The Rocky Flat site supports several species of reptiles and amphibians. Snake species include bull snakes, yellow-bellied racers, western terrestrial garter snakes, and prairie rattlesnakes. Western painted turtles are also present. Amphibian species include plains leopard frogs, Woodhouse's toads, boreal chorus frogs, and tiger salamanders. Boreal chorus frogs have been heard during vocalization surveys at the East Landfill Pond (K-H 1999, 2000b, 2001, 2002b).

Surface water at Rocky Flats supports a variety of aquatic macroinvertebrates, including snails and several orders of insects and crustaceans: Oligochaeta, Amphipoda, Decapoda, Hyracarina, Plecoptera, Ephemeroptera, Odonata, Trichoptera, Coleoptera, Diptera, Gastropoda, and Pelecypoda. Some ponds and creeks are inhabited by fathead minnows, common carp, white suckers, creek chubs, golden shiners, and green sunfish. Largemouth bass have been found in Ponds C-1 and A-2 and Lindsay Pond. However, the East Landfill Pond supports no fish and only a depauperate benthic macroinvertebrate community. Macrobenthic sampling conducted in 1991 documented only eight taxa of macrobenthic organisms present in the pond, including organisms in the groups: Gastropoda, Pelecypoda, Oligochaeta, Hydracarina, Amphipoda, and Diptera (DOE 1992b). Fish sampling conducted in 1999 at the pond captured no fish; however, a few frogs were captured. The No Name Gulch drainage is dry most of the time and surface water is present only during rain/snow events; therefore, no aquatic sampling has been conducted in the No Name Gulch drainage.

2.5.9.8 Sensitive Habitats and Endangered Species

Several wetlands identified at the Rocky Flats site are under the protection of state and federal wetlands laws. Wetlands around the East Landfill Pond were mapped by the U.S. Army Corps of Engineers (COE) (1994) and are described in the wetlands section above.

Only one federally listed species under the Endangered Species Act (ESA) (USC 1973) lives at the Site: the Preble's meadow jumping mouse. The mouse was discovered at the Site in the early 1990s and was federally listed as a threatened species in 1998 (63 FR 26517). Extensive studies were conducted by the DOE throughout the 1990's to collect information on the range, distribution, and habitat preferences of the mice in the drainages at the Site. Neither trapping around the East Landfill Pond nor telemetry work in the Walnut Creek drainage has documented the presence of the mouse at the pond or in the vicinity of the Present Landfill. RFETS has submitted annual reports to the USFWS which documents trapping activities related to the Preble's mouse. The USFWS has reviewed the reports and the information was entered into a data base. The only other federally listed wildlife species with the potential to occur at the Site is the bald eagle. Occasionally a bald eagle may visit the Site to forage for food, but no individuals live at the Site. The nearest known breeding location for the bald eagle is Standley Lake, located to the east.

No federally listed plant species occur at the Site. Two species that have the potential to occur here, the Ute ladies-tress orchid and the Colorado butterfly plant, are not known to occur on site. Field searches were made for these species from 1993 through 1995 and no individuals of these species were found (ESCO 1992, 1993, 1994).

2.5.10 Cover Vegetation

2.5.10.1 RFETS Vegetation Setting

Xeric tallgrass plants, including big and little bluestem, Indian grass and switchgrass are grasses that can be found in tallgrass prairie locations in Oklahoma, Kansas, Illinois and parts of Minnesota. These grasses are found here at Rocky Flats, in a xeric (dry) moisture regime dominantly because of unique Rocky Flats soil conditions. The unique RF soil conditions are driven by the nature of some, but not all soil parent materials on the Site. Some 900,000 years ago (and then in smaller hydrologic events to follow) a large "debris flow" deposited debris material on the west side of the Site. A debris flow is dirty slurry consisting of clay-size material, sand, gravel, cobbles, boulders and tree boles carried down a canyon from the west and deposited in a very gentle, nearly level, alluvial fan. On the west side of the RFETS, that deposit was possibly 70 feet deep, while on the east side, the deposit was possibly 10 feet deep. This debris flow deposited coarse materials and limited amounts of fine material. It is on these deep cobble- and boulder-laden deposits that these unusual tallgrass species are found, likely established units of tens of thousands of years ago. These tallgrass species, rare in the West but common Midwestern prairie plants were able to draw water from these soils for several reasons.

1. The soils were coarse, indicating that soil pores were large, indicating that soil capillary attraction was low, and indicating that these plants drew water that was not tightly bound by excessive amounts of fine-textured soil particles.
2. There was a presence of limited amounts of clay- and silt-sized particles that tended to hold the limited amount of precipitation received in this xeric moisture regime. That is, moisture was not lost to the pull of gravity, but rather retained on the clay and silt particles, much like a sponge retains water.
3. There was a presence of cobbles and boulders that displaced very limited soil moisture, 10 to 16 inches a year, to the limited clay- and silt-sized particles, the bank into which the moisture was deposited and later removed by plant roots.

Contrasting, fine textured soils derived from shale parent materials dominate the east side of the Site. On these soils, there is not enough water available to support the tallgrass prairie species because soil moisture is tightly bound by high hygroscopic attraction driven by small soil particles. Further, unlike the debris flow soils, these soils do not have cobbles and boulders to displace the very limited moisture to the clay- and silt-sized particles. Consequently, soils on the eastern side of the Site are dominated by xeric plant communities typical of eastern Colorado, midgrass and shortgrass communities of the Colorado high plains naturally selected to survive in this arid region.

2.5.10.2 Present Landfill Cover Vegetation Assessment

The proposed cover configuration (See figure 4) consisting of 2-feet of Rocky Flats Alluvium, 1-foot of rock and 10-inches of cushion soil (pit fines) will support Colorado short and medium plants for the following reasons:

1. Because the pit fines are clay-, silt- and fine-sand-sized particles. In this 10 inches over the moisture barrier, soil moisture carried by gravity from above will be held in a

moisture bank and released to plant roots because the amount of clay-sized soil particles is adequate to hold and release soil moisture, but not excessive to hold and bind water.

2. The 12 inches of coarse material provides cobble- and boulder-sized soil materials. These coarse materials will displace the limited soil moisture to the soil moisture bank.
3. Fine soil particles, clay-, silt- and fine-sand-sized particles will filter down into and be carried down into the 12-inch coarse rock zone by gravity, water movement, plant root growth, and soil organism activity.
4. The 2 feet of Rocky Flats alluvium will consist of the RF debris flow materials of 900,000 years ago; a very good soil texture driving the establishment of plants unique to this Site.

The soil materials proposed reasonably mimic the debris flow materials of the western portions of the site. Colorado shortgrass and midgrass plants are recommended for the Present landfill because unlike the 10- to 70-foot deep debris flow deposits, this artificial deposit is approximately 4 feet deep. While xeric tallgrass plant roots can grow to 15 or more feet long, this site will allow root growth to 4 feet. Therefore, this Present landfill site will become a Colorado high plans shortgrass to midgrass community site, not a xeric tallgrass prairie community. During periods of excessive precipitation, gravity will drain soil moisture to the moisture barrier and direct water away from the landfill. However, in periods of drought, the fine-textured soil particles in the bottom 10-inch horizon and fine soil particles in the coarse rock horizon will retain and release soil water to the plants above. Although this site will be prone to drought effects due to this 4-foot depth, the site and soil materials proposed are adequate to support drought tolerant Colorado high plains plant species. It can be expected that in periods of excessive precipitation, plant growth on this site will flourish. In periods of drought, this community will retreat, but these drought-tolerant plants will survive to flourish again when precipitation rebounds.

2.5.11 Surrounding Land Use and Population

The Site is bordered by State Highway 128 to the north, Indiana Street to the east, State Highway 72 to the south, and State Highway 93 to the west. Land directly north of Highway 128 is largely dedicated to open space. Land east of Indiana Street is zoned industrial/commercial to the north and open space to the south. The City of Broomfield owns the open space south of the Site, which includes Great Western Reservoir. The remaining land bordering the Site on the east is zoned agricultural, with a projected plan showing an open space designation. Previous Jefferson County open space east of RFETS is now owned by the City of Westminster. South of the Site, privately owned land is used for grazing and hay production, and is zoned for agricultural/commercial use. To the west, the Site is bordered by private land between the west boundary and State Highway 93 and is used for quarrying and industrial development. The land west of State Highway 93 is Boulder County open space. The land southwest of RFETS is owned by the State of Colorado, and is permitted for grazing and mining.

2.6 RFCA Action Level Comparison

This section summarizes the characterization and monitoring activities associated with the Present Landfill and compares the concentrations encountered to RFCA action levels (ALs). The information is taken from the OU 7 Final Work Plan Technical Memorandum (DOE 1994), reports prepared in accordance with the Site IMP (DOE 2000), Annual Groundwater Monitoring

Reports, and the Water Quality Assessment for the Present Landfill (Appendix D). This section summarizes the information contained in those documents but does not reiterate all the information.

2.6.1 Surface Soil

Surface soil samples were collected from the western end of the landfill, across IHSS 114 – Present Landfill, and in the vicinity of the East Landfill Pond including the spray areas (within the former OU 7 area). Surface soil samples from the western end of the landfill were analyzed for PCBs, metals, radionuclides, and nitrate as nitrogen (N). Surface soil samples from IHSS 114 – Present Landfill were analyzed for SVOCs, metals, inorganics, radionuclides, and asbestos. Surface soil samples from the vicinity of the East Landfill Pond were analyzed for radionuclides, metals, and nitrate as N (DOE 1994). The surface soil data indicate some metals, radionuclides, and SVOCs are present at concentrations greater than background (i.e., background means plus two standard deviations [metals] or the method detection limits [MDLs] for SVOCs) (Appendix D). All potential contaminant concentrations are less than RFCA Wildlife Refuge Worker (WRW) soil ALs (DOE et al. 1996).[8].

2.6.2 Subsurface Soil

Subsurface soil samples were collected from IHSS 114 – Present Landfill including the spray areas (within the former OU 7 area). Samples were collected from 2-foot intervals in alluvium and 4-foot intervals in bedrock. The deepest samples collected ranged from a depth of 22 to 60 feet. Subsurface soil samples were analyzed for metals, PCBs, radionuclides, SVOCs, VOCs, and nitrate as N. The subsurface soil data indicate some metals, radionuclides, SVOCs, and VOCs are present at concentrations greater than background (for metals) or MDLs (for SVOCs and VOCs) (Appendix E). All potential contaminant concentrations are less than RFCA WRW soil ALs (DOE et al. 1996).

2.6.3 Groundwater

Although groundwater monitoring began in 1986 (pursuant to the 1986 Compliance Order and CERCLA Agreement), a formal groundwater evaluation was not conducted until 1988. The uppermost aquifer in the vicinity of the Present Landfill is defined to include alluvium (Rocky Flats Alluvium and valley fill alluvium), colluvium, and weathered bedrock of the Arapahoe Formation. In the landfill proper, the uppermost aquifer also includes the landfilled wastes. Deep bedrock wells have been evaluated historically, and show no hydraulic connection with the overlying uppermost aquifer. Downgradient alluvial groundwater had elevated major ions, iron, manganese, strontium, and barium. However, these concentrations were either below background or lower than concentrations detected within the landfill. High salts farther downgradient in alluvial groundwater appeared to be from an unidentified natural source. Bedrock groundwater quality appeared to be largely influenced by mineral dissolution within the sandstone and claystone. High salt concentrations observed in bedrock wells were not seen in alluvial groundwater within the landfill (Rockwell International 1989).

[8] Additional ecological ALs are being developed and ecological risks will be evaluated in the Accelerated Ecological Screening Process and the CRA.

Historical sampling and analysis continued from 1988 through 1996, collecting data from approximately 53 groundwater monitoring wells, including wells located within the landfill. By 1996, the entire RFETS groundwater monitoring program was reevaluated based on a DQO process and was aligned with the new RFETS mission and RFCA requirements. Pursuant to the IMP and consistent with 6 Colorado Code of Regulations (CCR) 1007-3, Part 265, eight groundwater monitoring wells (four upgradient and four downgradient) at the Present Landfill area are monitored to determine impacts to groundwater quality (Figure 2). A summary of historical groundwater monitoring activities, beginning in 1986, is provided in Appendix B.

As a result, groundwater elevation and analytical data from the eight RCRA monitoring wells at the landfill were reviewed for the period of 2001 through mid-2003[9]. There are four upgradient RCRA wells (5887, 70193, 70393, and 70493), and four downgradient RCRA wells (4087, 52894, 52994, and B206989). (refer to Figure 2 for the locations.) Downgradient well 52994 was dry for the period reviewed and is not included in this discussion. It is also noted, that downgradient RCRA nested wells 52894 and 52994 may provide little future information, because they are dry much of the time. The main thrust of this discussion regards the differences in water levels within nested well pairs and differences in groundwater chemistry between the upgradient and downgradient wells.

Current groundwater quality was emphasized in this review of the eight RCRA wells. (For additional information refer to the historical annual groundwater monitoring reports.) Concentrations of contaminants are discussed with respect to Tier I and Tier II groundwater ALs. For the time interval reviewed, there were no detections of any analytes above Tier I groundwater ALs, with minimal potential to impact a surface water quality point of compliance (POC). The groundwater monitoring program has never indicated a contaminated groundwater plume from the Present Landfill.

A statistical analysis of upgradient versus downgradient water quality at the Present Landfill is presented in the 2001 Annual Rocky Flats Cleanup Agreement Groundwater Monitoring Report for the Rocky Flats Environmental Technology Site (SSOC, 2002). The results of this analysis indicated that significant differences in upgradient versus downgradient water quality were found for calcium, copper, lithium, magnesium, molybdenum, selenium, sulfate, total dissolved solids (TDS), vanadium, U-233/234, U-235, and U-238. Of these analytes, only vanadium and uranium-233/234 exhibited statistically significant increasing concentration trends in downgradient well B206989. However, calcium, copper, molybdenum, and vanadium concentrations were all below Tier II ALs. There are no groundwater ALs for magnesium or TDS.

The increase in metals and major cations and anions in downgradient groundwater, particularly in the shallow bedrock, has been attributed to a secondary contaminant source (K-H and RMRS 2001) or to other natural processes involving evapotranspiration, and mineralization along the groundwater flow path. These conjectures have been offered because historically the water quality in the unconsolidated material beneath the landfill does not suggest the Present Landfill leachate is the source for these apparent impacts to groundwater quality downgradient of the East Landfill Pond dam. Groundwater flow modeling also indicates that most, if not all, saturated zone groundwater within the UHSU and waste material upgradient of the Present Landfill seep is

[9] Prior years' data were not included because annual groundwater monitoring reports discuss this information.

discharged to the surface at the Present Landfill seep, and the dam limits further downgradient migration of this water in the subsurface.

Although none of the elevated contaminant concentrations in UHSU groundwater downgradient of the East Landfill Pond dam exceed Tier I ALs, and most do not exceed Tier II ALs, groundwater quality in the unconsolidated material beneath the landfill was examined as an additional evaluation of potential impacts of the Present Landfill leachate on groundwater quality because of the above noted observations. Data for wells other than the eight RCRA wells were evaluated, and details of the evaluation are presented in Appendix C. Groundwater downgradient of the East Landfill Pond will be further evaluated in the RFETS Groundwater IM/IRA.

2.6.3.1 Water Levels

The nested upgradient UHSU well pair 70393 and 70493 is located approximately 400 feet southwest of the western edge of the groundwater intercept system. Well 70393 is screened to the base of the Rocky Flats Alluvium and well 70493 is completed in the weathered bedrock just below the alluvium/bedrock contact. The screened interval and sand pack of this well does not connect with the overlying alluvium. These RCRA wells generally maintain a water elevation within approximately 1 foot, except for short periods after large recharge events such as the one experienced at RFETS during March 2003.

This situation varies from the scenario observed at downgradient nested UHSU well pair 4087 and B206989, located approximately 250 feet east of the crest of the East Landfill Pond dam. Well 4087 is screened to the base of the valley fill alluvium and well B206989 is completed in the weathered bedrock just below the alluvium/bedrock contact. The screened interval and sand pack of this well does not connect with the overlying alluvium. The head difference in these two RCRA wells at the most recent time that they both contained water (July 2002) was approximately 17 feet, with the deeper water level found in the weathered bedrock well.

2.6.3.2 Volatile Organic Compounds in Groundwater

For the analytical data reviewed from the downgradient RCRA wells, there were six sample events with VOC analyses from well 4087, seven from well B206989, and two from well 52894. There were no concentrations of any VOCs above Tier II ALs from any of the sampling events at any of the three wells, and very few detections of VOCs overall.

For the analytical data reviewed for the upgradient RCRA wells, there were 10 sample events with VOC analyses at wells 5887, 70193, and 70493; and 12 sample events for well 70393. Wells 5887 and 70193 exhibited no concentrations of VOCs above Tier II ALs from any of the sampling events and very few detections of VOCs overall. At nested well pair 70393 and 70394, the alluvial well (70393) had concentrations of tetrachloroethene (PCE), trichloroethene (TCE). and 1,1-dichloroethane (DCE) which were greater than their Tier II ALs. The concentrations show little variation with time and are near the Tier II ALs. Only TCE is found at a concentration greater than the Tier II ALs for every sampling event, ranging from 10 to 22.6 micrograms per liter (µg/L). The VOCs at this upgradient location are believed to be associated with the Property Utilization and Disposal (PU&D) Yard. The weathered bedrock well at this location (70493) did not contain any VOC concentrations greater than Tier II ALs and very few detections of VOCs overall.

These results indicate that there are no VOCs impacting downgradient groundwater quality resulting from the Present Landfill.

2.6.3.3 Metals in Groundwater

For the analytical data reviewed from the downgradient RCRA wells, there were five sample events with metals analyses from well 4087, six from well B206989, and two from well 52894. Well 52894 exhibited no metals results greater than Tier II ALs. For nested well pair 4087 and B206989, the weathered bedrock well (B206989) exhibited concentrations of selenium (ranging from 196 to 410 µg/L) and lithium (ranging from 1,100 to 2,140 µg/L) for all sampling events that were greater than their Tier II ALs. The current 2003 concentrations are well below the historic highs for the data set reviewed (2001-2003). There were also three thallium[10] results from this well that were above Tier II ALs, ranging from 2.4 to 4.6 µg/L. There were no concentrations of metals above Tier II ALs from alluvial well 4087.

For the analytical data reviewed for the upgradient RCRA wells, there were 10 sample events with metals analyses at wells 5887, 70193, and 70493, and 12 sample events for well 70393. The only metals detections above Tier II ALs at the upgradient RCRA wells were for thallium. Wells 5887, 70193, and 70493 contained two detections each; well 70393 contained one detection. The range for all seven of the detections was 2.2 to 6.2 µg/L.

2.6.3.4 Radionuclides in Groundwater

For the data reviewed, all three of the downgradient RCRA wells contained Tier II exceedances for the uranium isotopes uranium-233/234 and uranium-238 for all sampling rounds. This constitutes five and six samples from nested well pair 4087 and B206989, respectively, and two samples from well 52894. Weathered bedrock well B206989 also exhibited Tier II exceedances for U-235 for all sample events. The concentrations of uranium-233/234 and uranium-238 in well B206989 are three to seven times greater (ranging from 51 to 60.5 pCi/L for uranium-233/234, and 32 to 37.2 pCi/L for uranium-238) than the concentrations of these analytes in alluvial well 4087 (ranging from 8.7 to 19 pCi/L for uranium-233/234, and 5.7 to 14 pCi/L for uranium-238).

In contrast, the four upgradient RCRA wells, which all have at least 10 sampling events in the data reviewed, have very few Tier II exceedances for uranium isotopes, and the magnitude of the exceedances are lower by over an order of magnitude when compared to downgradient well B206989. All but one of the uranium-233/234 and uranium-238 Tier II exceedances in the upgradient wells were from weathered bedrock well 70493.

For the data reviewed, including all eight RCRA wells, tritium and strontium-89/90 were not detected above their Tier II groundwater ALs. Although tritium and strontium-89/90 are below RFCA ALs, all of the groundwater data for the Present Landfill were examined because elevated concentrations of these radionuclides have been reported in the past.

A review of all the data for all the wells in the landfill vicinity indicates that the highest concentrations of tritium occurred at wells 6387, 72093, and 72393, which were located near the center of the landfill. Concentrations have been as high as 3,500 pCi/L (well 72393).

[10] A statistical analysis of upgradient versus downgradient groundwater quality indicated that there was no statistically significant difference in thallium concentrations between upgradient and downgradient groundwater.

Concentrations are considerably lower at the northern edge of the landfill (wells 6087 and 6787) and farther downgradient (wells 72293 and 786), indicating the high concentrations of tritium are localized. At well B206989, which is located downgradient of the East Landfill Pond dam, there is only one reported value (506 pCi/L). All of these reported concentrations are well below the Tier II groundwater AL of 20,000 pCi/L.

Review of all the data for all the wells in the landfill vicinity indicates that only well B207089 had a reported strontium-89/90 concentration that exceeded the groundwater Tier II AL of 0.852 pCi/L. As shown in Table 1, the exceedance is a single occurrence on April 30, 1991 (11.17 pCi/L), and represents an anomaly relative to the remainder of the data. Therefore, groundwater quality at the landfill has not been impacted by strontium-89/90.

Table 1
Strontium-89/90 Activity in Well B207089 Over Time

Sample Date	Strontium-89/90 (pCi/L)
9/7/89	0.64
6/13/90	0.31
10/30/90	0.19
4/30/91	11.17
6/14/91	0.46
7/17/91	0.56
10/18/91	0.75
2/20/92	.004
4/28/92	0.04
7/10/92	-0.03
3/2/93	0.28
4/21/93	-1.2
10/12/93	0.08
4/8/94	.008
10/13/94	-0.01
1/12/95	-0.25

2.6.3.5 Nitrate and Sulfate in Groundwater

Nitrate and sulfate were both found in downgradient UHSU weathered bedrock well B206989 at concentrations above the Tier II AL for all seven sampling events within the time frame reviewed (Sulfate was only analyzed for twice). The nitrate values ranged from 19 to 69.4 milligrams per liter (mg/L). The sulfate values were 2,760 and 2,800 mg/L. Both nitrate and sulfate concentrations do not appear to have an increasing trend and have remained relatively constant. A statistical analysis of upgradient versus downgradient nitrate and sulfate groundwater quality has not been done for the most recent data. However, based on the 2001 analytical results, nitrate data do not indicate a statistically significant difference between upgradient and downgradient water quality. No other downgradient wells exhibited nitrate or sulfate concentrations greater than the Tier II Als for those analytes.

At the upgradient RCRA wells, all of which had at least 10 sample events, there were no detections of nitrate or sulfate above their Tier II Als.

2.6.3.6 Conclusions

Groundwater immediately downgradient of the East Landfill Pond contains elevated concentrations of nitrate, sulfate, selenium, lithium, and uranium isotopes (Table 2). Although the hydrologic flow model indicates all saturated zone flow upgradient of the Present Landfill seep is conceptualized as discharging at the surface, or immediately downgradient of the Present Landfill seep, there is some potential that seepage or underflow of the dam is possible, which may contribute to these elevated concentrations observed in downgradient weathered bedrock well B206989. The concentrations of analytes observed in this well have not changed significantly over time.

Table 2
Analytical Summary Of Downgradient UHSU Weathered Bedrock Well B206989, Tier II Exceedances from 2001 to Present

Dates	Radionuclides U-233/U-235/ U-238 (pCi/L)	Lithium (µg/L)	Selenium (µg/L)	Sulfate (mg/L)	Nitrate (mg/L)
2/01-3/01	NS	2140	272	NS	60
7/01	60.5/1.5/37.2	1100	280	2800	33.3
10/01	53.4/2.83/32.4	1150	303	2760	31.4
1/02	55.2/<Tier II/33.9	1150	259	NS	69.4
7/02	56.6/2.07/35.1	1200	410	NS	40.3
11/02	59.4/1.99/36.9	NS	NS	NS	19
1/03	51/2.1/32	1380	196	NS	54.1
Tier II AL	**1.06/1.01/0.768**	**730**	**50**	**500**	**10**

Notes: NS = not sampled;
Downgradient wells 4087 and 52894 had Tier II exceedances for uranium-233/234 and uranium-238 only (refer to text).

These results indicate selenium and lithium are present in downgradient groundwater quality at levels below RFCA Tier I ALs and are not increasing in concentration. The water quality assessment (Appendix D) supported by the hydrologic flow model and analytical data from the Present Landfill seep, indicates that these constituents may not be associated with the Present Landfill.

The continued presence of metals and anions (since 1986) in downgradient groundwater, particularly in the shallow bedrock, may also be attributed to other natural processes involving evapotranspiration, and/or mineralization along the groundwater flow path. These conjectures have been offered because historically the water quality in the unconsolidated material beneath the landfill does not suggest the Present Landfill leachate is the source for these apparent impacts to groundwater quality downgradient of the East Landfill Pond dam. Groundwater flow modeling also indicates that most, if not all, saturated zone groundwater within the UHSU and waste material upgradient of the Present Landfill seep is discharged to the surface at the Present

Landfill seep, and the dam limits further downgradient migration of this water in the subsurface. A water quality assessment is also provided in Appendix D.

The Actinide Migration Evaluation contains an investigation of historical groundwater uranium data. Historical monitoring data for UHSU wells downgradient of the East Landfill Pond and within the No Name Gulch drainage (Wells B206989, 4087, and 52894) show uranium levels to be below RFCA Tier I groundwater levels but above Tier II (RFCA Attachment 5, Table 2). A joint venture between CDPHE and DOE/Kaiser-Hill was conducted to accurately determine the concentration of uranium isotopic species for specific ground water and surface water locations at RFETS. Uranium ICP/MS project studies from 1999 to 2003 included samples from the Present Landfill locations SW-097 and well B206989. Project results determined that uranium-236 is not present in the groundwater downgradient of the East Landfill Pond, indicating only natural uranium to be present (K-H 2004). The study did show that a sample from SW097 had contaminant ratios but a low concentration of uranium (Pottorff 2004). Based on data from the 2000 Annual Groundwater Monitoring Report (K-H and RMRS 2000), total uranium at SW097 is 2.5×10^{-1} pCi/L, below the surface water standard of 10 pCi/L for Walnut Creek.

Because the East Landfill Pond dam limits downgradient groundwater flow, and elevated concentrations observed in well B206989 are downgradient of the dam and in weathered bedrock, the potential for this water to impact surface water is very low. The flow model indicates that most of this water would be subject to loss locally by means of evapotranspiration, while only a small portion would be subject to discharge as surface water flow. Surface water flow in the upper No Name Gulch drainage is more likely to infiltrate prior to reaching the lower region of the No Name Gulch drainage or reaching surface water monitoring station SW033, which is located along No Name Gulch drainage just above the confluence with Walnut Creek. However, groundwater downgradient of the East Landfill Pond will be further evaluated in the RFETS Groundwater IM/IRA.

2.6.4 Present Landfill Seep

Water discharging from the eastern face of the landfill upgradient of the East Landfill Pond was monitored at surface water station SW097 through 1995 (identified as the Present Landfill seep). Beginning in 1996, after installation of the passive seep interception and treatment system, monitoring began of the influent, system midpoint, and effluent at the treatment system at surface water stations SW00396, SW00296, and SW00196, respectively (Figure 2).

The East Landfill Pond dam impedes groundwater flow in surficial materials; therefore, the wells in surficial materials directly downgradient of the dam are often dry. Also, the alluvium and weathered bedrock at these locations are frequently dry or thinly saturated because the East Landfill Pond dam acts as a barrier to alluvial groundwater flow from the west. In addition, evapotranspiration demands of valley-bottom vegetation consume much of the available shallow groundwater in the No Name Gulch drainage during the summer months.

2.6.4.1 Organics

As discussed in detail in Appendix D, many organic compounds have historically been detected in the Present Landfill seep water. In general, organic detections are low and near the practical quantitation limits (PQLs)/surface water standards. However, only benzene, bis(2-ethylhexyl)phthalate, chloroethane, methylene chloride, naphthalene, PCE, TCE, and vinyl chloride exceeded surface water standards. However, examination of the most recent data for stations SW00196, SW00296, and SW00396 indicates that, with the exception of benzene, organic compounds were either nondetected or below their respective surface water standards. Benzene concentrations are very low and fluctuate about the surface water standard. Because the benzene surface water standard (0.0012 mg/L) is near the PQL (0.001 mg/L), the random fluctuations of concentrations near the surface water standard is to be expected from a measurement sensitivity perspective. Therefore, the organic compound data for the treatment system stations indicate that organic detections are at low concentrations near or below the surface water standards.

2.6.4.2 Inorganics

As shown in Appendix D, aluminum, antimony, barium, beryllium, cadmium, copper, lead, mercury, silver, and zinc exceeded surface water standards (RFCA Attachment 5, Table 1) in the Present Landfill seep water, primarily at SW097. However, with the exception of barium and zinc, all of these metals were detected at concentrations (with rare exceptions) below surface water standards at SW00196, which represent the most recent data for all of the surface water stations in the vicinity of the Present Landfill seep. Barium and zinc were present at SW00196 at concentrations just above their respective surface water standards, but the concentrations were below Site background levels (from the *Background Geochemical Characterization Report,* September 1993). Although metals were originally identified in the performance monitoring program for the Present Landfill seep treatment system, these observed low levels resulted in metals being excluded from the program. It is also noted that downgradient surface water quality at station GS03 (the Site boundary POC) meets the surface water standards for these metals.

2.6.4.3 Radionuclides

As shown in Appendix D, gross alpha, gross beta, plutonium-239, radium-226, radium-228, and tritium were detected at least once above the standards at SW097. However, in all cases, the concentration time series presented in Appendix D shows that the most recent activities of these radionuclides at this station were below surface water standards. Also, the radionuclide activities are below surface water standards at SW00196.

2.6.5 Landfill Gas

Gas flow through landfill waste and soil occurs in response to pressure gradients (i.e., advective flow), concentration gradients (i.e., diffusive flow), compaction and settling of wastes, barometric pressure changes, and displacement due to potentiometric surface fluctuations. Advection of landfill gas is typically the predominant transport mechanism. Off-gassing pressures up to 0.44 pound per square inch (lb/in^2) were measured at the Present Landfill during the Phase I RFI/RI.

The composition of landfill-generated gases was evaluated on the basis of screening-level data, which indicated 45 to 70 percent methane and 20 to 40 percent carbon dioxide. Concentrations of methane and carbon dioxide are highest in the eastern portion of the landfill where wastes are thickest and were most recently disposed. Gas concentration maps and cross sections are included in the OU 7 Final Work Plan Technical Memorandum (DOE 1994). Nonmethane organic compound concentrations range from 0 to 152,000 mg/L and average 30,000 mg/L, and include minor amounts of inorganic gases such as hydrogen sulfide.

EPA's Landfill Emissions Model Version 2.0 (LANDGEM) was used to calculate total landfill gas emissions by estimating methane, carbon dioxide, and nonmethane organic compound emissions individually and then summing the three model results. Model results indicated relatively low rates of landfill gas generation, with the majority (approximately 80 percent) of methane and total landfill gas production occurring by the year 2025, and almost all potential production occurring by the year 2075 (K-H 2002c). Landfill gas generation was reevaluated because the waste volume used for the LANDGEM calculation had included both organic and inorganic landfill wastes. Based on a revised calculation using the volume of organic waste contained in the landfill, the gas generation rate was 27 cubic feet per minute (cfm) (K-H 2002c), lower than the 50 cfm determined earlier.

In situ soil gas sampling was performed to characterize VOCs in the unsaturated zone of the landfill. VOCs detected at the landfill include 1,2-dichloroethene, 1,1,1-DCE, trichloroethene, methylene chloride, acetone, 2-butanone, toluene, xylene, and hydrogen sulfide. These data are considered screening data and were not directly compared to ALs.

3.0 REMEDIAL ACTION OBJECTIVES

The Present Landfill is being addressed as an accelerated action under RFCA, which provides for the coordination of DOE's response obligations under CERCLA and its closure obligations under RCRA/CHWA. As a landfill, the presumptive remedy is containment. The remedial action objectives (RAOs) for the Present Landfill are as follows:

- Prevent direct human and ecological exposure to contaminated soil or fill material at the Present Landfill;
- Provide containment of the Present Landfill with a RCRA Subtitle C interim status equivalent cover; and
- Protect surface water quality.

Alternatives have been developed to achieve these RAOs and meet the substantive RCRA Interim Status closure requirements.

4.0 PRESENT LANDFILL COVER AND SEEP ALTERNATIVES

The presumptive remedy for the Present Landfill is a cover. A Present Landfill cover alternatives analysis is provided in Section 4.1. Although the Present Landfill seep water meets water quality standards, occasional concentrations in the Present Landfill seep have been at or near the water quality standards. Therefore, a Present Landfill seep alternatives analysis is provided in Section 4.2.

4.1 Landfill Cover Alternatives Analysis

Three landfill cover alternatives (evapotranspiration cover, soil cover, and RCRA Subtitle C compliant cover) were analyzed for effectiveness, implementability, and relative cost. The results of this assessment are summarized in Table 3. The relative cost is provided for comparison purposes only and is not based on a site-specific design or cost estimate.

4.1.1 ET Cover

ET covers have recently been installed at project sites in Colorado. For the Present Landfill, a minimum cover soil thickness of 60 inches on top of a biota barrier would be required. The soil for the cover would be required to meet strict material and installation specifications to meet the requirements of the cover.

4.1.1.1 Effectiveness

Effectiveness considers whether the alternative provides protection of human health and the environment, and achieves the remedial objectives.

4.1.1.1.1 <u>Protectiveness</u>

An ET cover would protect human health and the environment by establishing a permanent barrier between the waste fill and surface. The effectiveness of the ET cover at meeting the infiltration requirements is highly dependent on the type of soil and proper placement of the soil over the landfill. Soil meeting very specific soil characteristics and workmanship specifications would be required.

Because of the CDPHE policy of meeting less than 1.3 millimeters per year (mm/yr) as the infiltration rate (per CDPHE comments) for non-RCRA guidance covers, application of an ET cover at the Present Landfill would require importing approximately 180,000 cy of soil. The soil would need to be imported from an off-site borrow area that meets specific soil characteristics, such as near Brighton, Colorado. This borrow area is approximately 31 miles from RFETS and would require more than 100 tandem semi truck loads of soil per day traveling through the Denver metropolitan area, and would likely include sections of Highways 128 and 93. This level of truck traffic would adversely impact traffic and is a major safety concern to RFETS.

Assuming operations are conducted for four 10-hour days per week, for six months, approximately 2,000 cy would be hauled each day. This rate corresponds to approximately 135 to 140 truckloads of soil per day. Each truck would make the 62-mile round trip, which would result in 8,680 vehicle-miles traveled (VMT) per day, or 842,280 VMT during the six months of operations.

The baseline analysis from the CID estimates 99 truck shipments per day for an average year, and 112 truck shipments per day for the highest volume year for the Closure Case (CID, Table 5.6-1 [DOE 1997]). Truck accidents were projected by using an estimated truck transportation accident fatality rate, measured in fatalities per VMT (CID, Table A-28). This rate, for Denver Metropolitan Area Deliveries, is 1.04×10^{-8} fatalities per VMT. The proposed action would exceed CID estimates of daily shipments and, during the six months when trucking is needed, would exceed CID estimates of fatality rates. Using the Closure Case projections for metropolitan area traffic, truck shipments required for the proposed action would cause approximately 8×10^{-3} accident fatalities during the six months of activity.

In conclusion, although the ET cover could provide long-term protection of human health, it would exhibit a short-term risk during construction. Additionally, the ET cover would require the establishment of vegetation that will use the infiltrating precipitation in the transpiration of the plants. The establishment of the vegetation would take several years, during which time the infiltration rate would exceed the EPA and CDPHE guidance cover infiltration rate of 1.3 mm/yr.

4.1.1.1.2 <u>Achieve Remedial Objectives</u>

This alternative meets the remedial objectives of preventing direct human and ecological exposure, achieves RCRA interim status compliance, and protects water quality by reducing the infiltration of stormwater through the cover.

4.1.1.2 Implementability

Implementability addresses the technical and administrative feasibility of implementing an alternative using the required equipment, services, and materials.

4.1.1.2.1 <u>Technical Feasibility</u>

ET covers require different construction processes/equipment than conventional covers because the fill cannot be overcompacted. Although this process is new, it is not overly difficult and uses standard construction equipment. Intense quality control would be required during construction of the ET cover.

However, if the cover were to become damaged through differential settling or erosion, the repair would be fairly easy. The cover repair would consist of the addition of the specified imported soil and revegetation.

4.1.1.2.2 <u>Availability</u>

Soil meeting the specific requirement for the ET cover is not readily available; the closest location is approximately 30 miles from the Site. The equipment to transport and build the cover is readily available, and includes standard earthmoving equipment.

4.1.1.2.3 <u>Administrative Feasibility</u>

The implementation of this alternative does not require permits or easements, and does not impact adjoining property. It would not inhibit the ability to impose institutional controls. Existing site management and access controls would be maintained until a comprehensive final plan is implemented in the future. The ET cover is consistent with the aesthetic qualities of the facility end use as a wildlife refuge with a vegetated cover.

4.1.1.3 Costs

The evaluation of costs should consider the capital costs to engineer, procure, and construct the required equipment and facilities, and the operation and maintenance (O+M) costs associated with the alternative.

4.1.1.3.1 <u>Capital Costs</u>

The cost estimated to construct this alternative is between $7 to $8 million.

4.1.1.3.2 Operation and Maintenance Costs

The operation and maintenance costs associated with this alternative involve the inspection and maintenance of the cover. Other monitoring costs, such as for groundwater and surface water, would also be included. O+M costs are considered low for this alternative.

4.1.1.4 Summary

Given the consideration for the safety concerns and infiltration rate requirements, other alternatives would be better suited for the Present Landfill. Given this, the ET cover is not the proposed cover alternative for the Present Landfill.

4.1.2 Soil Cover

The soil cover alternative for the Present Landfill would consist of a minimum addition of 2 feet of local on-site or imported soil on top of the existing soil cover. The soil cover would require approximately 68,000 cy of imported Rocky Flats alluvial soil. Soil meeting specific requirements would not be needed for this alternative.

4.1.2.1 Effectiveness

Effectiveness considers whether the alternative provides protection of human health and the environment, and achieves the remedial objectives.

4.1.2.1.1 Protectiveness

A soil cover would protect human health and the environment by establishing a permanent barrier between the waste fill and surface. However, the soil cover alone could not meet the infiltration requirements.

The soil cover would require approximately 65,000 cy of soil, reducing the number of trucks and VMT depending on the location of the source of the soil. Soil covers are currently used on military landfills under CERCLA as a presumptive remedy, where the majority of the waste is commercial refuse and construction debris co-disposed with limited amounts of hazardous constituents (EPA 1996). The Present Landfill is predominately commercial refuse and construction debris with limited amounts of hazardous wastes. In addition, the investigations and evaluations completed at the Present Landfill, and summarized in this IM/IRA, show that the landfill has had limited impact on the environment since it became inactive in 1998.

Additionally, soil covers are very easy to repair if they become damaged through differential settling or erosion; placement of soil and revegetation is all that would be needed to repair a soil cover.

In conclusion, the soil cover can provide long-term protection of human health and exhibits a lower short-term risk during construction than the ET cover. However, the soil cover cannot meet the infiltration requirements.

4.1.2.1.2 Achieve Remedial Objectives

This alternative meets the remedial objectives of preventing direct human and ecological exposure, and protects water quality by reducing the infiltration of stormwater through the cover.

However, the soil cover cannot achieve RCRA interim status compliance because it does not meet the infiltration requirements.

4.1.2.2 Implementability

Implementability addresses the technical and administrative feasibility of implementing an alternative using the required equipment, services, and materials.

4.1.2.2.1 Technical Feasibility

The soil cover requires conventional equipment and processes for construction. A moderate level of quality control would be required during construction of the soil cover.

If the cover becomes damaged through differential settling or erosion, repairing the cover is easy. The repair would consist of the addition of imported soil and revegetation.

4.1.2.2.2 Availability

Soil for the cover is readily available from sources close to the Site. The equipment to transport and build the cover is also readily available, and includes standard earthmoving equipment.

4.1.2.2.3 Administrative Feasibility

The implementation of this alternative does not require permits or easements, and does not impact adjoining property. It will not inhibit the ability to impose institutional controls. Existing site management and access controls would be maintained until a comprehensive final plan is implemented in the future. The soil cover is consistent with the aesthetic qualities of the facility end use as a wildlife refuge with a vegetated cover.

4.1.2.3 Costs

Evaluation of costs should consider the capital costs to engineer, procure, and construct the required equipment and facilities, and the O+M costs associated with the alternative.

4.1.2.3.1 Capital Costs

The cost estimated to construct this alternative is between $1.5 to $2 million.

4.1.2.3.2 Operation and Maintenance Costs

The O+M costs associated with this alternative involve the inspection and maintenance of the cover. Other monitoring costs, such as for groundwater and surface water, would also be included. O+M costs are considered low for this alternative.

4.1.2.4 Summary

Given the above assessment, RFETS believes that the Present Landfill is an appropriate site to apply the EPA presumptive remedy for a military landfill. However, the soil cover will not meet the EPA and CDPHE guidance cover infiltration rate of 1.3 mm/yr. Therefore, the soil cover is not the proposed cover alternative for the Present Landfill.

4.1.3 RCRA Subtitle C Compliant Cover

RCRA Subtitle C Guidance/Compliance covers have been installed on many landfills throughout the country and this technology is considered a likely alternative for the Present Landfill. This cover would require approximately 68,000 cy of onsite or imported soil to cover a geosynthetic composite liner placed on top of the landfill. The geosynthetic composite cover would consist of a geosynthetic clay liner (GCL) above the existing landfill soil cover. A flexible membrane liner (FML), made of polyvinyl chloride (PVC), linear low-density polyethylene (LLDPE) or high-density polyethylene (HDPE) is then placed on top of the GCL. Then a geocomposite drainage layer would be placed on top of the FML to drain infiltrating precipitation away from the FML. A cushion layer is placed above the geocomposite drainage layer to protect the geosynthetic composite liner from the cobble layer above. A cobble layer would be placed on top of the cushion layer to act as a barrier to burrowing animals. Finally, a layer of soil would be placed on top of the cobble layer to provide additional protection to the geosynthetic composite liner from damage. Surface vegetation will be established on this soil layer to enhance resistance to surface erosion and would provide an aesthetic cover appearance.

4.1.3.1 Effectiveness

Effectiveness considers whether the alternative provides protection of human health and the environment, and achieves the remedial objectives.

4.1.3.1.1 Protectiveness

A RCRA Subtitle C Compliant cover would protect human health and the environment by establishing a permanent barrier between the waste fill and surface, and would meet the infiltration requirements.

This cover would require approximately 68,000 cy of on-site or imported soil to cover the geosynthetic composite liner placed on top of the landfill, greatly reducing the number of truck trips. Imported soil for this cover could also be obtained from a closer local borrow area, thereby reducing the VMT.

In conclusion, the RCRA cover can provide long-term protection of human health and the environment, exhibits a lower short-term risk during construction, and can meet the infiltration requirements.

4.1.3.1.2 Achieve Remedial Objectives

This alternative meets the remedial objectives of preventing direct human and ecological exposure, protects water quality by reducing the infiltration of stormwater through the cover, and can achieve RCRA interim status compliance because it meets the infiltration requirements.

Table 3
Comparison of Landfill Cover Design Alternatives

Alternative	Description	Effectiveness	Implementability	Comparative Cost
ET Cover	A minimum cover thickness of 60 inches on top of a biota barrier with an integrated gas venting layer (if required).	Recent studies and modeling indicate an ET cover would be effective after the full establishment of vegetation. Monitoring within the cover and at the waste boundaries would be conducted to verify the cover's performance during and after the establishment of vegetation. The infiltration rate would be less than or equal to 1.3 mm/yr after vegetation is fully established. Cover would be easy to repair. Vegetation cover would require monitoring and maintenance.	ET covers require different construction processes/equipment than conventional covers because the fill cannot be overcompacted. Although this process is new, it is not overly difficult and uses standard construction equipment. Safety concerns are very high due to the large volume of truck traffic required to bring large amounts of soil to the site from distant off-site borrow areas.	$7.0MM to $8.0MM
Soil Cover	Two feet of soil from local borrow sources over the existing soil cover.	A soil cover would effectively meet the RAOs given the landfill's limited impact on the environment. It would be easy to repair should the cover become damaged. The soil cover would not meet the infiltration rate of 1.3 mm/yr. The vegetative cover would require monitoring and maintenance.	Soil covers are relatively easy to construct with standard construction equipment. Using imported fill from nearby borrow areas reduces the traffic-related safety concerns.	$1.5MM to $2.0MM
RCRA Subtitle C Compliant Cover	A GCL, 40-mil FML, geocomposite drainage layer, and a soil cushion layer of 10 inches followed by a 1-foot cobble layer to stop burrowing animals. The cobble layer would be covered with a vegetated 2-foot layer of soil (Rocky Flats Alluvium). A passive gas venting system would be included in the design.	Although such a cover is considered highly effective, differential settling may cause liner failure. Repairs would require extensive excavation of the cover and complex repair procedures. Performance monitoring is not required for presumptive remedies. The cover would meet the infiltration rate of 1.3 mm/yr. The vegetative cover would require monitoring and maintenance.	Subtitle C covers have been constructed since the 1970s. Although the process is more difficult than soil covers, in that it requires complex quality assurance, the methods required for construction are well established and there are many contractors capable of completing the construction. Using local sources for materials reduces traffic safety concerns.	$6.5MM to $7.5MM[11]

[11] This comparative cost does not include five foot of compacted soil components of a traditional RCRA Subtitle C cover as referenced in the August 2, 2002 IM/IRA previously released for public comment.

4.1.3.2 Implementability

Implementability addresses the technical and administrative feasibility of implementing an alternative using the required equipment, services, and materials.

4.1.3.2.1 Technical Feasibility

Geosynthetic composite liner covers require trained personnel to install the composite materials; however, many have been installed over the last 25 years and trained crews are available for installation. The soil and rock covering the composite liner uses conventional earthmoving equipment and processes. Additionally, the composite cover is made of generally inert materials that will remain viable for a very long time (hundreds of years) because the materials are protected from the sun and will not be exposed to excessive volatile or corrosive compounds.

Because the geosynthetic composite liners are made from plastic materials, they are prone to tearing with differential settling. Some settling would be expected at the Present Landfill over time; however, very limited differential settling is expected because the landfill has been closed for several years. If differential settling was large enough to tear the lining materials, repair of the liner would require bringing earthmoving equipment to the Site to excavate down into the liner to conduct the repairs. Contractors specializing in the repair of these types of liners would also be required to perform a quality repair.

4.1.3.2.2 Availability

Materials for the cover are readily available from sources close to the Site. The equipment to transport and build the cover is readily available, and includes standard earthmoving equipment. Composite liner installation would be performed with trained crews that are also readily available.

4.1.3.2.3 Administrative Feasibility

The implementation of this alternative does not require permits or easements, and does not impact adjoining property. It will not inhibit the ability to impose institutional controls. Existing site management and access controls would be maintained until a comprehensive final plan is implemented in the future. The cover is generally consistent with the aesthetic qualities of the facility end use as a wildlife refuge with a vegetated cover.

4.1.3.3 Costs

The evaluation of costs should consider the capital costs to engineer, procure and construct the required equipment and facilities, and the O+M costs associated with the alternative.

4.1.3.3.1 Capital Costs

The cost estimated to construct this alternative is between $6.5 to $7.5 million.

4.1.3.3.2 Operation and Maintenance Costs

The operation and maintenance costs associated with this alternative involve the inspection and maintenance of the cover. Other monitoring costs, such as for groundwater and surface water, would also be included. O+M costs are considered low to medium for this alternative.

4.1.3.4 Summary

Given that the RCRA Subtitle C Compliant cover (geosynthetic composite liner cover) would meet the mandated infiltration rate and reduce the hazards associated with the transportation of large amounts of special fill material (associated with the ET cover), RFETS is proposing the geosynthetic composite cover for the Present Landfill.

4.2 Landfill Seep Alternatives

The alternatives considered for the landfill seep are presented in Table 6. The alternatives have been developed based on the determination that the passive seep interception and treatment system meets the RCRA Wastewater Treatment Unit (WWTU) exclusion and the substantive requirements of National Pollutant Discharge Eliminating System (NPDES) permit. When the cover is completed, flow of the seep is expected to decrease as shown by the hydrogeologic modeling. As the seep flow decreases, the concentration of constituents in the seep could likely increase. The level of increase cannot be predicted, and post-accelerated action monitoring will be conducted as described in other sections of this IM/IRA. An increased concentration of constituents in the landfill seep is not an indicator of direct cover performance. The expected decrease in flow of the seep is an indicator of the cover reducing the infiltrating precipitation and reduce the saturated zone within the landfill.

As provided in Table 4, the proposed alternative for seep management is the passive seep interception and treatment system. The other alternatives that were evaluated could be implemented as contingent actions in the future if the seep exceeds effluent limitations established within this IM/IRA (refer to Section 6.0).

4.2.1 Alternative 1 - No Further Treatment

Under this alternative no treatment (passive or active) of the landfill seep is proposed. However, short- or long-term monitoring of the seep would continue.

4.2.1.1 Effectiveness

Effectiveness considers whether the alternative provides protection of human health and the environment, and achieves the remedial objectives.

4.2.1.1.1 <u>Protectiveness</u>

Because the seep is not a source of drinking water, there is no impact to human health. In the short term, it is not likely that this alternative would impact water quality. As the seep flow decreases, the concentrations of constituents in the seep could increase. Monitoring the seep will be conducted to track the level of constituents in the seep.

Table 4
Seep Management Alternative Evaluation

Alternative	Description	Effectiveness	Implementability	Relative Cost	Conclusions
No Further Treatment	No passive or active treatment of landfill seep.	Highly effective if treatment not required.	No implementation required.	None, except monitoring	Not selected because there is a potential for constituent concentrations to increase as the seep flow decreases.
Passive Seep Interception and Treatment	Seep water is intercepted in a perforated pipe that directs water to a flow measurement tank. Water is then directed to a treatment tank where water flows over a series of flagstone steps (waterfalls) before flowing into the East Landfill Pond.	Effective for removal of low concentrations of volatile constituents. Not highly influenced by iron and manganese levels and precipitation.	Easy to construct system if elevation differential exists to allow waterfall effect.	Low	Selected alternative
Store and Off-Site Treatment /Disposal	System involves collection of the seep water into a sump, pumping into a storage tank, and then removal of the water by a tanker truck for disposal at a municipal wastewater treatment plant or hazardous waste treatment/disposal facility.	Highly effective because water is never discharged into existing drainage.	Fairly easy to design and build; however, it would require electrical power and access roadway to implement. Would also require routine maintenance and monitoring by trained mechanical technicians. Potential safety concern due to off-site transportation.	High to very high due to power and roadway requirements, continual maintenance and monitoring, and the possible high costs for disposal.	Not a selected alternative due to high cost and potential problems with public acceptance of off-site transportation and disposal.
On-Site Treatment	Consists of iron/manganese removal, and VOC and inorganic constituent removal by aeration, filtration, and ion exchange systems.	Treatment would result in very clean water with most, if not all, constituents below detectable levels.	Requires detailed evaluation and design. Complex operating system requires a trained wastewater treatment operator. Requires electrical power, process instrumentation, and access roadway.	Very high due to the complexity of the equipment and systems needed to control the system. Requires routine and frequent operation, monitoring, and maintenance for continuous use.	Not selected because the seep is impacted only with VOCs, and other alternatives are more cost effective. This alternative is also highly complex and costly, requiring significant operator attention and system maintenance.

4.2.1.1.2 Achieve Remedial Objectives

This alternative meets the RAO of protecting surface water quality under the current conditions. Monitoring of the seep is required to track the level of constituents in the seep.

4.2.1.2 Implementability

Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of the required equipment, services, and materials.

4.2.1.2.1 Technical Feasibility

This alternative is technically feasible because there is no construction or operation requirements, successful performance can be demonstrated through monitoring, there are no environmental conditions requiring adaptation, and no permits are required to implement this alternative.

4.2.1.2.2 Availability

No equipment or materials would be required for this alternative. However, personnel and services would be required for seep monitoring, and they are readily available.

4.2.1.2.3 Administrative Feasibility

The implementation of this alternative does not require permits or easements, and does not impact adjoining property. It will not inhibit the ability to impose institutional controls at the Present Landfill. Existing site management and access controls would be maintained until a comprehensive final plan is implemented in the future.

4.2.1.3 Costs

Evaluation of costs should consider the capital costs to engineer, procure and construct the required equipment, services, and facilities, and the O+M costs associated with the alternative, emphasizing long-term stewardship.

4.2.1.3.1 Capital Costs

No capital costs are associated with this alternative.

4.2.1.3.2 Operation & Maintenance

Short-term seep monitoring costs would be incurred with this alternative; however, these costs are relatively low.

4.2.2 Alternative 2 – Passive Seep Interception and Treatment

Passive seep interception and treatment consists of seep water intercepted in a perforated pipe that directs water to a flow measurement tank where the flow of the seep is measured. Water then flows over a series of flagstone steps (waterfalls) within a tank to enhance the removal of vinyl chloride and benzene before flowing into the East Landfill Pond. A passive seep interception and treatment system already exists but would be modified to treat the seep water in a tank as outline above. Short- and long-term monitoring would be required with this alternative.

4.2.2.1 Effectiveness

Effectiveness considers whether the alternative provides protection of human health and the environment, and achieves the remedial objectives.

4.2.2.1.1 Protectiveness

Because the seep is not a source of drinking water, there is no impact to human health: however, the treatment provided by the passive seep interception and treatment system would provide increased protection of the environment. As the seep flow decreases, the concentrations of constituents in the seep could increase. This alternative would reduce the impact to water quality if levels of volatile constituents increase in the seep. Monitoring of the seep after the passive seep interception and treatment would be conducted to track the level of constituents.

4.2.2.1.2 Achieve Remedial Objectives

This alternative meets the RAO to protect surface water quality. Monitoring would be required after treatment to track the level of constituents.

4.2.2.2 Implementability

Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of the required equipment, services, and materials.

4.2.2.2.1 Technical Feasibility

This alternative is technically feasible because there is limited construction required, successful performance can be demonstrated through monitoring, and there are no environmental conditions requiring adaptation. Maintenance of the passive seep interception and treatment system would be required to inspect the system components and routinely clear vegetation and debris away from the system.

4.2.2.2.2 Availability

Equipment and materials would be required for this alternative and they are readily available. Personnel and services would be required for monitoring and maintenance, both of which are readily available.

4.2.2.2.3 Administrative Feasibility

The implementation of this alternative does not require easements or impact adjoining property. The implementation of this alternative does require an NPDES permit (refer Section 6.0). It would not inhibit the ability to impose institutional controls at the Present Landfill. Existing site management and access controls would be maintained until a comprehensive final plan is implemented in the future.

4.2.2.3 Costs

Evaluation of costs should consider the capital costs to engineer, procure and construct the required equipment, services, and facilities, and the O+M costs associated with the alternative emphasizing long-term stewardship.

4.2.2.3.1 Capital Costs

Low capital costs are associated with this alternative to modify the existing passive seep interception and treatment system.

4.2.2.3.2 Operation and Maintenance

Short and long term monitoring and maintenance costs would be incurred with this alternative; however, these costs are relatively low.

4.2.3 Alternative 3 – Store and Off-Site Treatment/Disposal

This alternative involves the collection of the seep water into a sump, pumping the water into a storage tank and then removal of the water by a tanker truck for disposal at a municipal wastewater treatment system or a permitted hazardous waste treatment/disposal facility.

4.2.3.1 Effectiveness

Effectiveness considers whether the alternative provides protection of human health and the environment, and achieves the remedial objectives.

4.2.3.1.1 Protectiveness

Because the seep is not a source of drinking water, there is no impact to human health. However, the treatment provided by the off-site system would provide increased protection of the environment. As the seep flow decreases, the concentrations of constituents in the seep could increase; however, this increase is not expected to alter the implementation of this alternative. Monitoring of the collected seep water would be conducted to track the level of constituents and volume to determine the cost of treatment and disposal requirements by off-site facilities.

4.2.3.1.2 Achieve Remedial Objectives

This alternative meets the RAO of protecting surface water with the collection and removal of the seep water. Monitoring of the seep would be required to track the level of constituents and seep volume to determine the cost of treatment and disposal by off-site facilities.

4.2.3.2 Implementability

Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of the required equipment, services, and materials.

4.2.3.2.1 Technical Feasibility

This alternative is fairly easy to design and build; however, it would require electrical power and an access roadway to implement. Successful performance can be demonstrated through monitoring and disposal records. The construction and maintenance of the collection system, access road, and electrical power system is not consistent with the overall facility end state. No permits are required to implement this alternative; however, written agreements would be needed for the transportation, treatment, and disposal of the seep water by a municipal wastewater treatment plant or a permitted hazardous waste treatment/disposal facility. Trained technicians would be required to provide long-term maintenance of the collection system, roadway, and electrical system.

4.2.3.2.2 Availability

Equipment, materials, and services are readily available for this alternative; however, the facility for the disposal of the seep water is uncertain.

4.2.3.2.3 Administrative Feasibility

The implementation of this alternative does not require permits or easements, but would require written agreements for the transportation, treatment, and disposal of the collected seep water. The installation of electrical power and construction of the required access roadway could impact adjoining property. It will not inhibit the ability to impose institutional controls at the Present Landfill. Existing site management and access controls would be maintained until a comprehensive final plan is implemented in the future.

4.2.3.3 Costs

Evaluation of costs should consider the capital costs to engineer, procure and construct the required equipment, services, and facilities, and the O+M costs associated with the alternative, emphasizing long-term stewardship.

4.2.3.3.1 Capital Costs

The capital costs associated with the construction of the collection and electrical power system, and the roadway would be high and in the range of several hundred thousand dollars.

4.2.3.3.2 Operation & Maintenance

O+M costs would include maintenance of the collection and electrical systems and the access roadway, the use of electrical power, and the cost of transportation, treatment, and disposal of the seep water. Seep monitoring costs would also be required. The actual costs would be very dependent on the volume of seep water collected and would impact the transportation, treatment, and disposal cost of this alternative.

4.2.4 Alternative 4 – On-Site Treatment

This alternative consists of on-site water treatment processes to remove iron and manganese from the seep water prior to treatment for the removal of volatile constituents. Aeration or oxidation processes would then be used to remove the volatile constituents, followed by an ion exchange system for the removal of inorganic constituents. Other treatment processes would be considered during the design of the on-site treatment system to determine the most cost-effective system for the seep water.

4.2.4.1 Effectiveness

Effectiveness considers whether the alternative provides protection of human health and the environment, and achieves the remedial objectives.

4.2.4.1.1 Protectiveness

Since the seep is not a source of drinking water, there is no impact to human health: However, treatment provided by the on-site system would provide increased protection of the environment. As the seep flow decreases, the concentrations of constituents in the seep could increase; however, this increase is not expected to alter the implementation of this alternative. In addition, this potential increase would be included in the design basis of the treatment system. Long term monitoring of the on-site treatment system would be conducted for O+M functions.

4.2.4.1.2 Achieve Remedial Objectives

This alternative meets the RAO of protecting surface water quality with the high level of treatment of the seep water. Monitoring of the on-site treatment system would be conducted for O+M functions.

4.2.4.2 Implementability

Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of the required equipment, services, and materials.

4.2.4.2.1 Technical Feasibility

This alternative is highly complex to design and build, and would require electrical power and an access roadway to implement. Successful performance could be demonstrated through monitoring of the treatment system operation. The construction and maintenance of the on-site treatment system is not consistent with the overall facility end state. No permits are required to implement this alternative; however, written agreements would be needed for the maintenance of the equipment and treatment media replacements. Long-term maintenance of the on-site treatment system would require highly trained water treatment plant technicians.

4.2.4.2.2 Availability

Equipment, materials, and services are readily available for this alternative.

4.2.4.2.3 Administrative Feasibility

The implementation of this alternative does not require permits or easements, but would require written agreements to maintain the treatment system. The installation of electrical power and construction of the required access roadway could impact adjoining property. It would not inhibit the ability to impose institutional controls at the Present Landfill. Existing site management and access controls would be maintained until a comprehensive final plan is implemented in the future.

4.2.4.3 Costs

Evaluation of costs should consider the capital costs to engineer, procure and construct the required equipment, services, and facilities, and the O+M costs associated with the alternative, emphasizing long-term stewardship.

4.2.4.3.1 Capital Costs

The capital costs associated with construction of the on-site treatment and electrical power systems, and the roadway would be very high and would be expected to exceed $500,000.

4.2.4.3.2 Operation & Maintenance

Operation and maintenance costs would include maintenance of the treatment and electrical systems and the access roadway, use of electrical power, and O+M of the treatment system. Seep monitoring costs would also be required. The actual costs would be very dependent on the volume and level of constituents in the seep water and would impact the overall treatment cost of this alternative.

5.0 PROPOSED ACTION

The proposed action is the landfill presumptive remedy of containment. This engineered control will be accomplished by installing a RCRA Subtitle C compliant cover and continued operation of a modified passive seep interception and treatment system before the Present Landfill seep water is discharged to the East Landfill Pond. Elements of the proposed action and closure plan are described in this section. Post-accelerated action monitoring is presented in Appendix A.

5.1 Present Landfill Cover

The existing surface of the landfill will be grubbed and graded to meet the required slopes (3 to 5 percent) before the geosynthetic liner material is placed. The RCRA-compliant composite cover will be installed over the hazardous materials and a soil cover will be installed on the east slope of the landfill. The details of the cover will be presented in the engineering design drawings and specifications that will be completed and approved by EPA and CDPHE. The slope stability of the existing east face of the landfill will also be evaluated in the design.

The landfill cover will be a designed geosynthetic composite liner consisting of a geosynthetic clay liner (GCL) above the existing soil cover of the landfill (Figure 4). A flexible membrane liner (FML) made of polyvinyl chloride (PVC), linear low density polyethylene (LLDPE) or high density polyethylene (HDPE) will then be placed on top of the GCL. Then a geocomposite drainage layer is placed on top of the FML to drain infiltrating precipitation away from the FML. A cushion layer will be placed above the geocomposite drainage layer to protect the geosynthetic composite liner from the cobble layer above. A cobble layer will be placed on top of the cushion layer to act as a barrier to burrowing animals. Finally, a layer of soil will be then placed on top of the cobble layer to provide additional protection to the geosynthetic composite liner from damage.

The aforementioned layers will be designed to meet the RCRA requirements of minimizing infiltration and erosion. Additionally, surface vegetation will be established on this soil layer to enhance resistance to surface erosion, prevent intrusion of noxious weeds and burrowing animals, and to provide an aesthetic appearance to the cover, using appropriate native seed mixes.

Drainage ditches along the perimeter of the landfill cover will be modified to allow the free drainage of the geosynthetic composite cover and drainage layer, and to direct surface water runoff away from the landfill. These ditches will generally be vegetation-lined with riprap applied in areas of steeper channel slope where erosion might be expected. The geosynthetic composite liner will be placed below the frost line established during the design for the location and weather conditions at the Present Landfill.

Four gas vents were installed in the existing landfill cover in 1992. The existing vents consist of vertical standpipes that extend into the underlying waste to allow passive venting of landfill gas. These vents will be removed before placement of the cover, and replaced with barometric vents as determined by the detailed engineering design. Removal of the vents will be accomplished by either pulling the casing, plugging the casing with bentonite or grout, or cutting the pipe. If the casing is left in place, it will be cut off below the existing ground surface and plugged using either bentonite or grout.

A Monitoring and Maintenance Manual will be prepared following the cover design and will incorporate the regulatory requirements for inspection and maintenance of the cover and for groundwater monitoring.

5.2 Present Landfill Seep

The existing seep interception and treatment system will be modified and maintained (Figure 5). The modified seep treatment system will be designed to measure the flow of the seep, to allow sampling before and after treatment, and to treat the seep water by passive aeration. The seep treatment system will include flows from the landfill groundwater intercept system. The landfill groundwater intercept system piping will be interrupted immediately outside the landfill and new piping will be installed to route any flow into the seep treatment system. Maintenance of the passive seep interception and treatment system will include quarterly visual inspection of the components, vegetation control, and erosion control. In addition, flow from the GWIS will be sampled quarterly for the full suite of Appendix VIII constituents for the first year after construction is completed to determine the quality of water entering the seep treatment system. These data will be evaluated to determine if modifications are required of the seep treatment system.

A Monitoring and Maintenance Manual will be prepared following the design and will incorporate the regulatory requirements for inspection and maintenance of the passive seep interception and treatment system and for monitoring of the Present Landfill seep.

5.3 East Landfill Pond Sediments

The sediments in the East Landfill Pond will be removed and placed under the RCRA Subtitle C-compliant cover. This part of the accelerated action will include the following steps:

- Remove the water currently in the pond. This water will be pumped to the A-series ponds or to the on-site incidental water management system.
- Remove the vegetation along the banks of the pond only as needed to remove the sediments.
- Remove the sediments down to native material and place the removed sediments within the existing surface soils of the landfill and within the boundary of the RCRA Subtitle C-compliant cover. Cement or other pozzolanic material will be used to solidify the sediments if they are too wet at the time of placement.
- Confirmation samples will be taken after the sediments are removed. The samples will be evaluated in support of a RCRA contained-out determination to demonstrate that no hazardous wastes remain in the pond. Additionally, data will be evaluated and incorporated into the comprehensive risk assessment (note: this RCRA process will proceed independently of the accelerated action certification process).
- After removal of the sediments, water will be placed back into the pond to a level conducive for wetland plant growth and new wetland plants will be planted according to the Wetland Mitigation Plan, Appendix G.

5.4 Accelerated Action Requirements for Protectiveness and Short- and Long-Term Effectiveness

The objectives of this action are met through installation of the landfill cover and the modifications to the passive seep interception and treatment system. While this IM/IRA does not encompass post-closure requirements (see RFCA paragraph. 25bd), RFCA paragraph 97 requires that it address compliance with post-closure requirements. Post closure requirements must either be incorporated in a post-closure permit or other enforceable mechanism. The post-closure requirements encompass many of the long-term stewardship activities applicable to the Present Landfill. For further discussion refer to Appendix A.

5.4.1 Institutional Controls

Institutional controls include administrative controls such as use restrictions, and are intended to prevent or limit adverse exposure to residual contamination, and/or limit access to a site to ensure the ongoing security and effectiveness of facilities such as engineered controls or monitoring devices. Physical controls that restrict access to a site are included as a subset of institutional controls. General and specific post-accelerated action institutional controls for RFETS as a whole are currently being evaluated by DOE and the regulatory agencies, and in consultation with the U.S. Fish and Wildlife Service (USFWS), and the community.

Figure 4
Geosynthetic Composite Cover

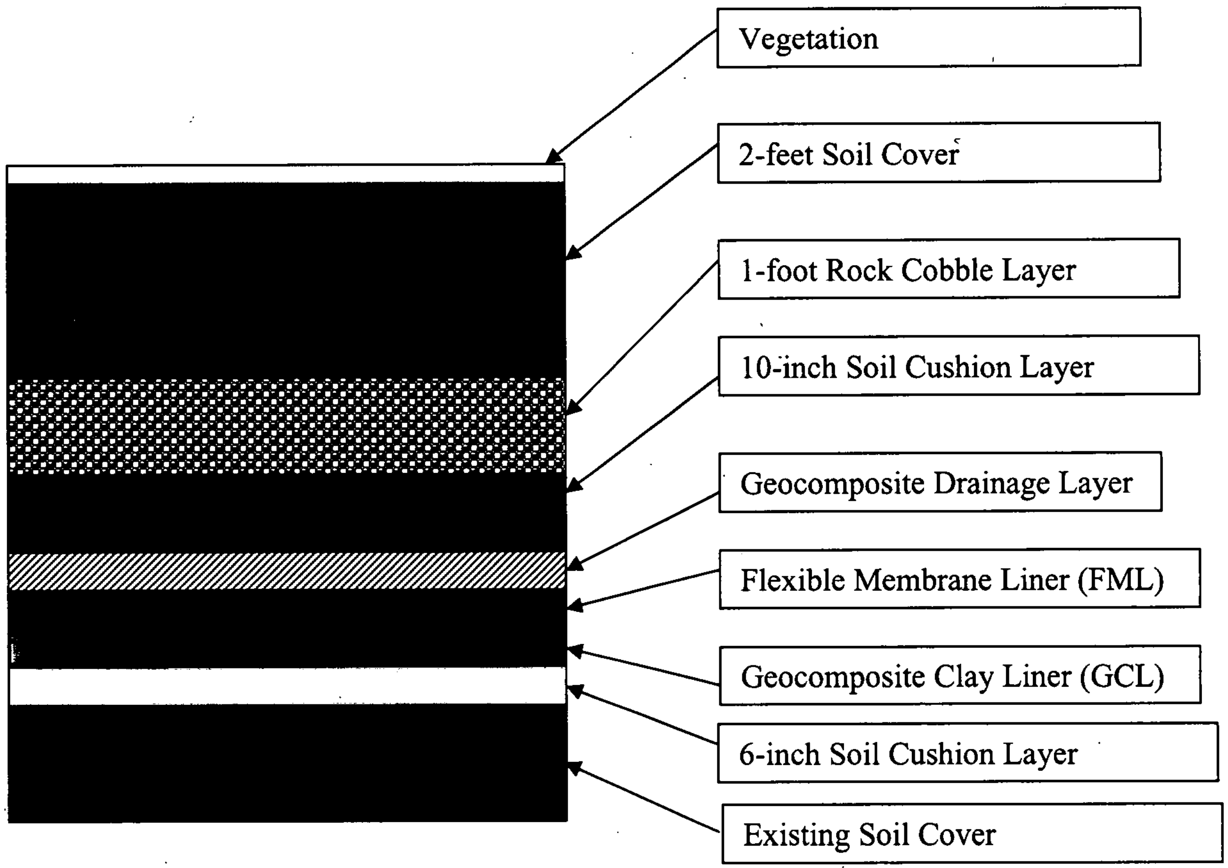
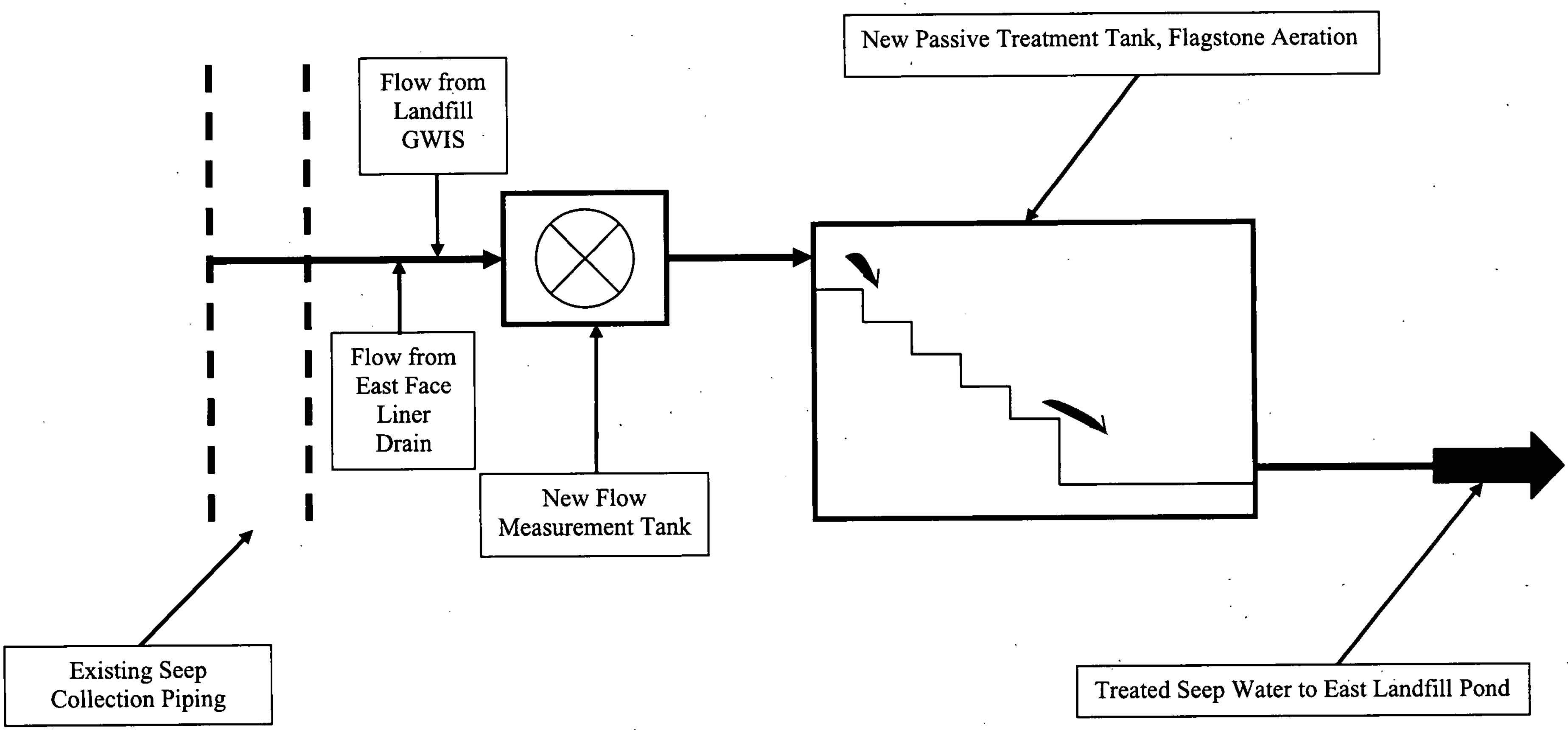


Figure 5
Passive Seep Interception and Treatment System



The institutional controls that will be implemented at the Present Landfill for this proposed action are described below. Controls described in Items 3 through 9 will be included in a post-closure permit or other enforceable mechanism. The RFCA parties have not resolved whether the federal government is required to comply with Colorado's SB01-145. If it is determined that Colorado's SB01-145 does apply to federal agencies, an environmental covenant will be required for the Present Landfill, and the controls described in Items 3 through 9 will also be included in such a covenant. The Present Landfill controls are as follows:

1. Current Sitewide security and access controls will be maintained until completion of the RFETS Closure Project, currently scheduled for December 2006, but will be replaced by equivalent controls for the Present Landfill and other specific areas for which security and access controls are required.

2. In accordance with the Rocky Flats Wildlife Refuge Act of 2001 (Pub.L. 107-107, Sec. 3171-3182 [December 28, 2001]), DOE will retain jurisdiction over the engineered controls associated with the proposed action.

3. Prohibitions on drilling and pumping of groundwater wells for uses other than the remedy will be in place.

4. Prohibitions on the use and excavation of the cover and the area in the immediate vicinity of the cover will be established.

5. Prohibitions on drilling on and in the immediate vicinity of the cover will be established.

6. Prohibitions on disruption of the seep and the passive seep interception and treatment system until it is determined that the passive seep interception and treatment system is no longer needed will be established.

7. To avoid adverse impacts, roads and trails will not be allowed on the cover or the immediate vicinity of the cover. Signs may be erected that indicate vehicles are prohibited from specific areas and that direct vehicle traffic appropriately. A determination will be made during project construction as to whether signs or fences will be used as the preferred means of restricting access.

8. Upon construction completion, fencing around the cover, or specific locations on or around the cover, may also be considered to limit the potential for damage or tampering with the location. Signs and markers may be used as controls to delineate the landfill boundary; outline digging, fishing, swimming, groundwater, and surface use restrictions; and/or describe access restrictions to the landfill cover and monitoring locations for the cover.

9. Inspection of these institutional controls will be performed quarterly to determine their continuing effectiveness. Results of these inspections will be reported annually.

Final institutional and physical controls for the accelerated action will also be documented in the Closeout Report.

5.4.2 Worker Health and Safety

All work under this proposed action will be controlled using the Site Integrated Safety Management System (ISMS) and the Integrated Work Control Program (IWCP). A project-specific Health and Safety Plan (HASP) will be developed to address the safety and health hazards of project execution and specify the requirements and procedures for employee protection. The Occupational Safety and Health Administration (OSHA) construction standard for Hazardous Waste Operations and Emergency Response, 29 Code of Federal Regulations (CFR) 1926.65, will be used as the basis for the HASP. In addition, DOE Order 5480.9A, Construction Project Safety and Health Management, applies to this project. This Order requires preparation of an Activity Hazard Analysis (AHA) for each task, which includes identifying each task, the hazards associated with each task, and the controls necessary to eliminate or mitigate the hazards. The AHAs will be included in the HASP.

Data and controls will be continually evaluated. If field conditions vary from the planned approach (for example, when unanticipated hazards are encountered, such as contaminated debris and airborne contamination), an AHA will be prepared for the new conditions, and work will proceed according to the appropriate control measures.

6.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

As required by Part 4 of RFCA, the proposed action will be performed to the extent practicable in compliance with ARARs under CERCLA. ARARs have been identified for the proposed action consistent with the NCP, the preambles to the proposed and final National Contingency Plan (NCP), and CERCLA Compliance with Other Laws Manuals Part I and Part II (EPA 1988, 1989).

The ARARs are provided in Appendix F. This section provides additional detail for the ARARs related to RCRA/CHWA closure, the treatment and discharge of the landfill seep, air, surface water, and wildlife.

RFCA paragraphs 16 and 17 established the requirements under which the CERCLA permit waiver applies. For any action that would require a permit except for the CERCLA waiver, RFCA Paragraph 17 requires that the following information be included in the submittal:

a. Identification of each permit that would be required;

b. Identification of the standards, requirements, criteria, or limitations, which have to be met in order to obtain each permit; and

c. Explanation of how the response action proposed will meet the standards, requirements, criteria, or limitations identified in subparagraph b (immediately above).

This information is included for those aspects of the proposed action that are eligible for the permit waiver.

6.1 RCRA Unit Closure Requirements

This section focuses only on RCRA hazardous waste and constituents for purposes of demonstrating closure of the Present Landfill. This section of the IM/IRA is the Closure Plan for the Present Landfill and this IM/IRA serves as notification to CDPHE of the pending closure of the Present Landfill. No specific form is required for notification of closure. The Present Landfill will be closed consistent with the RCRA/CHWA closure performance standard for interim status units (6 Colorado Code of Regulations [CCR] 1007-3, Part 265.111), which requires DOE to close the unit in a manner that:

- Minimizes the need for further maintenance;
- Controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to groundwater, surface water, or atmosphere; and
- If the unit is a landfill, complies with the closure and post-closure requirements of Part 265.310.

To demonstrate compliance with these closure performance standards, the following sections discuss each of these requirements.

6.1.1 Minimize the Need for Further Maintenance

Minimal maintenance will be required for the Present Landfill since a RCRA Subtitle C compliant cover will be placed over the landfill. See Figure 4 for the proposed cover configuration components. A cobble layer is proposed to deter the intrusion of borrowing animals. The cobble layer is cover with an additional 2-feet of soil to further protect the geosynthetic liner. Vegetation of a soil cover is planned to further reduce erosion, although vegetation and weed control measures will be employed to maintain a healthy stand of vegetation consistent with the wildlife refuge end-state. Storm water runoff from the cover will utilize perimeter drainage ditches around the landfill and will require minimal maintenance to ensure the drainage's remain open and unobstructed.

6.1.2 Control, Minimize, or Eliminate Post-Closure Escape of Hazardous Waste, Hazardous Constituents, Contaminated Runoff, or Hazardous Waste Decomposition Products and Leachate

The post-closure escape of hazardous waste from the Present Landfill is controlled in that the landfill is located within a valley and sits on a relatively low-permeability unconsolidated bedrock foundation, which minimizes the lateral and downward migration of hazardous waste. A RCRA Subtitle C-compliant cover will be placed over the Present Landfill. This cover will minimize the infiltration of precipitation through the landfill, thereby minimizing the migration of hazardous waste, hazardous constituents, hazardous waste decomposition products, and leachate from the landfill.

6.1.3 Comply with Landfill Closure Requirements

The landfill closure requirements, as defined in 6 CCR 1007-3 265.310(a), require that a final cover be placed over the landfill and that it be designed and constructed to:

- Provide long-term minimization of migration of liquids through the closed landfill;
- Function with minimum maintenance;
- Promote drainage and minimize erosion or abrasion of the cover;
- Accommodate settling and subsidence so that the cover's integrity is maintained; and
- Have permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

As previously mentioned, a RCRA Subtitle C-compliant cover will be placed over the Present Landfill. Figure 4 provides the proposed cover configuration components. The detailed design of the cover will take several months to complete. However, this type of cover has been shown to function with minimal maintenance, while it promotes drainage and prevents direct contact with the landfill waste and interstitial soil. The RCRA Subtitle C-compliant cover design provides long-term minimization of migration of liquids through the closed landfill through the design of the geosynthetic composite liner. Erosion of soil and other materials on the surface is anticipated to be minimal to non-existent. Because this landfill has been in existence for approximately 35 years, settling and subsidence is anticipated to no longer be significant issues and the cover components are designed to maintain the cover's integrity. The Subtitle C cover has a permeability less than the existing subsoils present beneath the landfill.

6.1.4. Closure Activities

The overall project approach is presented in Section 5.0. Detailed design specifications will be presented in the final design documents for approval by EPA and CDPHE. The construction contractor will be held in strict conformance to the final construction design drawings and specifications.

Quality assurance/quality control (QA/QC) inspection and testing will be performed during construction of the RCRA equivalent Subtitle C cover in accordance with the Construction Quality Control (CQC) Plan as well as the construction specifications. These specification outline specific inspection and testing requirements for all materials and construction performance, necessary documentation, procedures for correcting nonconforming items, and the party responsible for each aspect of the CQC. All materials and placement of materials for the cover will be subject to inspection and testing to ensure conformance to the specifications.

Ancillary activities performed concurrently with construction of the RCRA Subtitle C cover will include wetlands protection, surface water management, and site security. Compensatory mitigation for unavoidable impacts to wetlands will be provided in accordance with a wetlands mitigation plan. Surface water runoff will be controlled by grading the surface of the landfill. Surface water will drain to the perimeter drainage ditches and routed to No Name Gulch. The water level in the East Landfill Pond may be lowered to allow better access for construction activities during closure by transferring water to Pond A-3. Seep management and landfill gas monitoring will be performed as a continuation of the accelerated action until construction of the cover begins.

Site security will be maintained during and after construction activities. Signs will be posted warning of potential danger at the landfill.

6.1.5. Closure Certification

After installation of the RCRA Subtitle C cover, DOE will provide EPA and CDPHE with a certification that the Present Landfill cover has been installed in accordance with the final approved design documents (including approved changes and field modifications, if applicable). An independent, registered professional engineer will sign this certification.

6.2 RFCA Attachment 10

RFCA Attachment 10 requires that a cover be placed over the Present Landfill. As described above in Section 5.5, post-closure controls, monitoring and maintenance requirements for the cover will be implemented at the Present Landfill in a CHWA Part 265 post-closure permit or other enforceable mechanism, as briefly described in Appendix A. After the cover has been installed, groundwater POC and alternate concentration limits (ACLs) (if appropriate) for the unit will be designated and identified in the post-closure permit, or other enforceable mechanism, as discussed in Section 5.5.

RFCA Attachment 10 requires that groundwater "design concentration limits" (DCLs) be calculated as a design criteria for the cover. DCLs are calculated at the unit boundary and assume an ongoing release from the unit, but at levels that are protective of human health and the environment, consistent with the RFETS Vision (RFCA Appendix 9). DCLs are back-calculated from the surface water quality standards in RFCA Attachment 5, Table 1.

Groundwater at the unit boundary exits the ground at the Present Landfill seep. The Present Landfill seep is contaminated with low levels of volatile organics, notably benzene and vinyl chloride, sometimes at levels slightly above RFCA Attachment 5, Table 1 surface water ALs and MCLs for drinking water. The cover is designed to reduce infiltration by over 90 percent and effectively reduce the formation of leachate that could contribute to groundwater contamination. The analysis of groundwater in Appendix D downgradient of and lateral to the unit boundary indicates that the Present Landfill, without any cover other than the present 1 to 4 feet of soil is not contributing contaminants to groundwater in the vicinity. Based upon the foregoing considerations, the RCRA Subtitle C cover proposed for the Present Landfill is not based upon a DCL criterion, but rather upon a design infiltration rate that meets RCRA Subtitle C requirements and guidance criteria.

6.3 Air

The proposed action has the potential to generate fugitive particulate emissions, but very little potential for hazardous air pollutant (HAP) emissions because the waste material in the landfill will not be disturbed. Subpart H of 40 CFR Part 61 contains the requirements for monitoring and reporting activities within DOE facilities that have the potential to emit radionuclides other than radon. Potential emissions from the proposed action that may affect 40 CFR 61 compliance have not been identified; however, normal perimeter National Emission Standards for Hazardous Air Pollutants (NESHAPs) compliance air monitoring will be conducted during the cover installation.

Colorado Regulation No. 1 (5 CCR 1001-3) governs opacity and particulate emissions. Section II of Regulation No. 1 addresses opacity and prohibits stack emissions from fuel-fired equipment exceeding 20 percent opacity. Section III addresses the control of particulate emissions. Fugitive particulate emissions will be generated from construction and transportation activities. During construction activities, dust minimization techniques, such as water sprays, will be used to minimize suspension of particulates. In addition, construction activities will not be conducted during periods of high wind. The substantive requirements of Regulation No. 1 will be incorporated into a Dust Control Plan, which will define the level of particulate control for the project.

Colorado Regulation No. 3 (5 CCR 1001-5) provides CDPHE with the authority to inventory emissions and Part A describes Air Pollutant Emission Notice (APEN) requirements. Air quality management subject matter experts will evaluate the project emissions and, if applicable, an APEN will be prepared to facilitate CDPHE's inventory process.

The final surface of the landfill cover will appropriately reduce the potential post-action wind erosion of soil and subsequent particulate emissions. Significant air emissions are not anticipated after the closure construction is complete.

6.4 Compliance with NPDES ARARs

6.4.1 Permit Waiver Requirements

Appendix F to this IM/IRA presents the ARARs that apply to the Present Landfill closure. Specifically, water discharged from the landfill will be subject to regulation under the Federal Water Pollution Control Act (aka Clean Water Act [CWA]), 33 U.S. Code (USC) 1251 *et seq.*, and the NPDES regulation under 40 CFR Part 122. For the activities described in this document, the substantive requirements of 40 CFR 122.28 will be met to the extent practicable.

6.4.2 Present Landfill Point Source Discharge Compliance

The following information specifically addresses the requirements listed above.

6.4.2.1 Permit Required

The Present Landfill seep water is intercepted in a perforated pipe that directs water into a passive treatment system. The seep water flow is first measured and is then directed to a passive treatment tank where flagstone steps (waterfall) treat the water before flowing into the East Landfill Pond. This description of the treatment unit and outfall requires an NPDES discharge permit, except as excluded under CERCLA 121(d)(1). The monitoring point for NPDES purposes will be at the discharge from the WWTU tank system.

6.4.2.2 Requirements to Obtain a Permit

The requirements for NPDES permit applications are set forth in 40 CFR Part 122, which specifies that an applicant must complete an EPA Form 2-C, and supply all relevant facility information. The Present Landfill, Present Landfill seep description, and water quality information contained in this IM/IRA are the same as would be included in an NPDES permit application. When issued, the NPDES permit specifies effluent limitations for the prospective outfall, based on water quality standards applied to the receiving water and the potential impacts of the discharge on the receiving waters. The permit would also require routine monitoring of the effluent and routine reports to the issuing agency.

6.4.2.3 How the Present Landfill IM/IRA Meets the Requirements

The NPDES outfall will be at the effluent of the seep treatment system. (This is the monitoring point for NPDES purposes, which is at the discharge from the WWTU tank system.) The parameters that will be monitored are VOCs and metals. The effluent limits are the surface water standards applicable for the receiving water, as listed in RFCA Attachment 5, Table 1. After the cover is installed, monitoring of the treatment system effluent will be conducted quarterly until the first CERCLA review. A validated exceedance of an effluent limit will trigger an increase in monitoring to monthly for three consecutive months. Continued exceedances during the three-month period will trigger consultation between the RFCA parties to evaluate whether a change to the remedy is required, additional parameters need to be analyzed, or a different sampling frequency is required. If no exceedances are detected during the first CERCLA review period, then the monitoring frequency will change from quarterly to either semiannually or annually based on the review of the data by the RFCA parties.

During the sampling period, a validated exceedance of an effluent limit will trigger an increase in monitoring to monthly for three consecutive months. Continued exceedances during the three-month period will trigger consultation between the RFCA parties to evaluate whether a change to the remedy is required, additional parameters need to be analyzed, or a different sampling frequency is required. During future CERCLA periodic reviews, the RFCA parties will evaluate whether continued monitoring of the treatment system effluent is required beyond the yearly sampling required under the existing law.

Finally, NPDES permits require that routine reports of monitoring activities be submitted to the permitting authority. Results of the monitoring described in this section will be reported annually. These reporting obligations meet the substantive requirements of the NPDES permit and become part of the Administrative Record (AR).

6.4.3 RCRA Wastewater Treatment Unit Exclusion

The Present Landfill seep discharge contains landfill leachate that is mixed with groundwater. Because the discharge from the Present Landfill seep treatment system will be regulated under NPDES, it is not a solid waste and therefore not a hazardous waste at the point where it is a regulated NPDES discharge (Section 261.4[a][2] of 6 CCR 1007-3). Under CERCLA, this NPDES discharge is eligible for a permit waiver as described in sections 6.5.1 and 6.5.2.

For the leachate collection and treatment system upstream of the NPDES-regulated discharge point under sections 100.10(a)(6) and 265.1(c)(10) of the Colorado Hazardous Waste Regulations, owners and operators of WWTUs, as defined in 6 CCR 1007-3, Part 260.10, are exempt from hazardous waste permit requirements.

A WWTU refers to a device that:

- Is part of a wastewater treatment facility that is subject to regulation under either Section 402 or Section 307(b) of the CWA;
- Receives and treats or stores an influent wastewater which is a hazardous waste as defined in Section 261.3 or . . . : and
- Meets the definition of a tank or tank system in Section 260.10.

In the current configuration of the seep treatment system, Present Landfill seep water is intercepted in a perforated pipe that directs water to a flow measurement tank. The flow is then directed to a treatment tank where the seep water is treated by flowing over a series of flagstone steps (waterfalls) before flowing into the East Landfill Pond. To meet the requirements for a WWTU exclusion, treatment of the seep water will occur within a tank.

CDPHE issued a Policy on Wastewater Treatment Unit Exemption in June 1991 and a Guide to Implementing the Division's Treatment Unit Policy in January 2000 (collectively referred to as the CDPHE WWTU Policy and Guide) that established certain conditions or criteria related to the requirements that must be met for the exemption to apply.

Requirement 1:

The CDPHE WWTU Policy and Guide provides that generally, the unit must be in the immediate vicinity of the main structures and/or point(s) of discharge of the wastewater treatment facility, and the unit must be directly involved in the actual treatment or storage of the wastewater.

The point of discharge of the passive seep interception and treatment system is a point source discharge of the wastewater treatment facility that is subject to NPDES permitting requirements as identified in Section 6.5, Compliance with NPDES ARARs. The system is directly involved in the actual treatment and storage of wastewater.

Requirement 2:

Under the CDPHE WWTU Policy and Guide the following criteria must be met for a hazardous waste to qualify as a "wastewater":

5. The WWTU must be part of a "designated facility" as defined in 6 CCR 1007-3, Part 260.
6. Water content of the waste must be at least 90 percent by weight.
7. Total organic carbon (TOC) of the waste must be less than 1 percent (from 6 CCR 1007-3, Part 268 definition).
8. The flash point of any phase of the waste must be above 140 degrees Fahrenheit.
9. The waste must not have any phase that would cause it to exhibit the characteristic of reactivity, as defined in 6 CCR 1007-3, Section 261.23.
10. Any facility utilizing the WWTU exemption must be able to demonstrate compliance with the above criteria through records of hazardous waste determinations, waste characterizations, or analysis.
11. Thermal treatment is not an exempt treatment process unless specifically approved by CDPHE in writing.

Criterion 1 applies to shipment of wastewater to an off-site facility for disposition, and Criterion 7 is not part of the proposed action. A review of the historical analytical information for the Present Landfill seep water shows that it meets Criteria 2 through 5. Therefore, under the criteria, the Present Landfill seep water is considered wastewater.

Requirement 3:

6 CCR 1007-3, Part 260.10 defines "tank" as a stationary device, designated to contain an accumulation of hazardous waste constructed primarily of nonearthen materials (e.g., wood, concrete, steel, plastic) that provides structural support. A "tank system" means a hazardous waste storage or treatment tank and its associated ancillary equipment and containment system. Under the CDPHE WWTU Policy and Guidance, tanks that manage wastewater must be a dedicated part of the WWTU.

In the existing seep treatment system, the Present Landfill seep is collected in 4-inch slotted pipes from the bottom of the east face of the Present Landfill. The existing passive treatment system will be modified to first direct the seep water flow into a flow measurement tank. Seep water from the flow measurement tank will then be introduced to a passive treatment tank consisting of a series of flagstones (waterfalls) for treatment before being discharged into the East Landfill Pond (Figure 5).

The system meets the Part 260.10 definition of a tank or tank system and is a dedicated part of the WWTU.

The seep treatment system will be modified to meet the requirements of a WWTU so that treatment will occur within a dedicated tank or tank system, as defined in 6 CCR 1007-3 Part 260.10.

6.5 Surface Water

The East Landfill Pond will be allowed to discharge through an overflow structure into No Name Gulch, which is connected to Walnut Creek. Surface water monitoring for the Creek is conducted at the existing Indiana Street surface water point of compliance (POC).

6.5.1 Stormwater

Given the expected conditions at the Present Landfill site, no significant surface water impacts are anticipated as a result of stormwater events. However, because the total area of the project is greater than 1 acre and the location is outside the IA, which has an effective NPDES Permit for Storm Water, the proposed action would require an NPDES Storm Water Permit for Construction Activities. However, because it is a CERCLA action, Paragraphs 16 and 17 of RFCA establish the requirements under which a CERCLA permit waiver applies. For any action that would require a permit except for CERCLA, Paragraph 17 requires that the information presented below be included in the submittal.

6.5.1.1 Permit Required

Because the landfill cover construction project is larger than 1 acre in size and lies outside of the Site IA, an NPDES General Storm Water Permit for Construction Activities would be required. The permit is found at 40 CFR Part 122, and is obtained by filing a Notification of Intent (NOI) with EPA. This IM/IRA serves as the NOI for the Present Landfill.

6.5.1.2 Requirements to Obtain a Permit

Because the stormwater permit for construction activities is a general permit, it has been through public comment and promulgated by EPA. Obtaining the permit is through the NOI (i.e., a letter submittal to the agency containing basic information about the project). The permit requires the installation of best management practices (BMPs) and structural stormwater controls, such as silt fences, to protect downstream water from potential surface water contaminants (for example, sediment-laden runoff). These requirements will be part of the cover design.

6.5.1.3. How Stormwater Control Measures Meet the Requirements

The total area of disturbed soil is approximately 25 acres, including the area of the landfill to be resurfaced (23 acres) and miscellaneous construction activities (2 acres). Surface water control measures will be used to minimize surface water contact with potentially contaminated soil or groundwater and minimize erosional effects during the construction activities. Precipitation falling on areas where construction is in progress will be diverted to existing surface water drainage ditches. Other shallow ditches will be temporarily constructed as needed to prevent sediment-laden stormwater from flowing directly into No Name Gulch. Newly constructed soil surfaces will be stabilized using revegetation hydromulch, straw-mulch, silt fencing, riprap and other stormwater BMPs to minimize soil erosion, sediment transport, and surface water quality degradation until the required vegetation is established. The use of straw-mulch, adequately spaced silt fences, and other appropriate measures minimizes soil loss and allows the vegetation to become established.

6.5.2 Remediation Wastewater

Remediation wastewater generated during construction activities is not expected; however, if produced, it will be managed consistent with provisions of the RFCA Implementation Guidance Document (IGD) (DOE et al. 1999). Remediation wastewater, if produced, will be collected, characterized, and transferred to an approved treatment unit for processing (i.e., the Site sewage treatment plant or another approved on-site or off-site treatment facility), or it will be directly discharged in accordance with requirements of the Site's Incidental Waters Program (K-H 2003).

6.6 Wildlife

Construction activities may impact migratory birds protected by the Migratory Bird Treaty Act, and the Fish and Wildlife Conservation Act. Due to the variations in potential impacts depending upon the season and nesting schedules for migratory birds, the substantive requirements of these federal statutes will be evaluated by the Site Ecology group prior to conducting activities associated with the proposed action. The substantive requirements identified during the evaluation will be implemented throughout the construction process.

7.0 ENVIRONMENTAL IMPACTS

Paragraph 95 of RFCA specifies that National Environmental Policy Act (NEPA) values will be included in RFETS decision documents (DOE et al. 1996). While environmental consequences are addressed in part throughout this decision document, this section of the IM/IRA specifically examines environmental impacts and satisfies the RFCA requirement for NEPA values assessment.

The environmental consequences analysis relies heavily on analyses and conclusions reached in the CID (DOE 1997) and 2000 CID Update Report (DOE 2001), both of which focus on cumulative impacts resulting from on-site closure activities. In general, the proposed action will have very little adverse long-term impacts on a variety of resource areas, including air quality, water quality, traffic congestion, and ecological resources. In some instances, the impacts could be intense during construction. However, impacts will not notably affect human health and safety or the environment, and they will be temporary and controlled through mitigation actions. For example, dust will be controlled with water sprays during placement of the cover.

7.1 Impacts to Air Quality

The purpose of this section is to assess the potential impacts to air quality associated with the proposed installation and maintenance of the soil cover, including fugitive dust emissions and methane emissions.

7.1.1 Potential Fugitive Dust Emissions

When a cover is placed over the landfill, this action will impact air quality; however, the impacts to air quality will be temporary and will primarily occur from the operation of construction equipment. The primary pollutant generated as a result of the proposed action will be fugitive dust, which includes total suspended particulates (TSP), particulate matter 10 microns in size or smaller (PM_{10}), and particulate matter 2.5 microns in size or smaller ($PM_{2.5}$). Dust emissions from cover construction activities will be controlled with practical, economically reasonable, and technologically feasible work practices, as required by Colorado Air Quality Control Commission (CAQCC) Regulation No. 1. Specifically, on-site dust will be controlled through dust minimization techniques, such as the use of water sprays to minimize suspension of particulates, and terminating earthmoving operations during periods of high wind, as detailed in the Dust Control Plan. Particulate emissions will be short-term and controllable, and emissions are not expected to be above enforceable National Ambient Air Quality Standards (NAAQSs) at the RFETS perimeter. Therefore, potential impacts to workers and the public from the proposed action will not be significant.

In addition, dust and emissions from the waste materials in the Present Landfill will not be an air quality concern, because excavation and movement of the waste materials is not part of the proposed accelerated action and will remain undisturbed.

7.1.2 Potential Methane Emissions

Methane emissions from the Present Landfill have been estimated using EPA's LANDGEM model. This model was used to estimate total landfill gas emissions by estimating methane, carbon dioxide, and nonmethane organic compound emissions individually, and then summing the three results. The model indicated relatively low rates of landfill gas generation, with the majority (approximately 80 percent) of methane and total landfill gas production occurring by the year 2025. Landfill methane emissions are not anticipated to impact the environment.

7.1.3 Potential Equipment Emissions.

Cover construction activities will also include operation of vehicles, heavy machinery, and other equipment that generate other criteria pollutants. Estimated concentrations of other criteria and HAPs provided in the CID (DOE 1997) were well below the most restrictive occupational exposure limit, with the exceptions of sulfur dioxide, nitrogen dioxide, and carbon monoxide, which approached 50 percent of the most restrictive occupational exposure limit. The CID (DOE 1997) identified the primary sources of these pollutants as diesel-powered emergency generators used to supply backup power at RFETS. According to the 2000 CID Update Report (DOE 2001), maximum daily emissions will remain approximately the same as forecast in the CID (DOE 1997). Equipment emissions from cover construction activities are expected to be substantially less than the CID (DOE 1997) and 2000 CID Update Report (DOE 2001) estimates; therefore, impacts to workers and the public are not a concern.

7.2 Impacts to Surface Water

Construction activities associated with installation of the cover will result in surface disturbance from the clearing of vegetation, excavation and salvage of existing soil material, blading and leveling of land preceding construction, and the potential for accidental uncovering of waste materials. Potential impacts to surface water during the construction phase include increased erosion and subsequent sediment loading to the East Landfill Pond, perimeter drainage ditches, and No Name Gulch during storm events. The RCRA Subtitle C-compliant cover will result in minimal potential for both sheet and channelized runoff, as well as wind and water erosion, resulting in decreased sedimentation of ditches and No Name Gulch.

Cover construction may require some soil obtained from off-site commercial operations or onsite sources. NEPA analysis of on-site excavation of these borrow materials has been addressed in other site decision documents. Off-site facilities address these issues through permits issued to the facility.

The remedial construction activities are not expected to have any physical contact with contaminated soil or waste materials. In the event equipment and personnel come in contact with potentially contaminated materials during construction, decontamination will be performed at the RFETS main decontamination facility to reduce potential impacts to surface water.

Long-term impacts will be minimized because the cover will minimize infiltration of precipitation and subsequent contact with contaminants, thus reducing the volume of Present Landfill seep water discharged to the surface. In addition, the cover will incorporate surface drainage features to prevent runon/runoff and provide erosion control. The proposed action will result in a decrease in the risk of contaminants reaching surface water by reducing the precipitation contacting contaminated soil or waste materials and the continued operation of a modified passive seep interception and treatment system designed to meet surface water standards. Precipitation falling within the boundary of the landfill will be drained from the cover and diverted away from the landfill. Surface water drainage from areas outside the landfill boundary will be prevented from flowing onto the landfill and diverted around the boundary. Using appropriate surface-reclamation measures, a RCRA Subtitle C-compliant cover will be established on the final surface of the landfill. The establishment of a RCRA Subtitle C-compliant cover on stabilized slopes, contours of the landfill, and surrounding disturbed surfaces will greatly reduce erosion to levels similar to surrounding areas.

Post-accelerated action monitoring activities will include inspections of the landfill surface and associated drainage ditch conditions. Observations of the cover and evidence of soil erosion and loss will be included in the routine inspection and maintenance activities. Further erosion control measures and regrading will be implemented if maintenance inspections indicate the landfill surface reclamation is not as effective as planned.

In summary, the potential impacts to surface water from the proposed action will not be significant.

7.3 Impacts to Groundwater

Current sources of groundwater recharge to the UHSU include infiltration of precipitation, snowmelt, stormwater runoff, and possible downward seepage from the East Landfill Pond. The level of groundwater rises annually in response to spring and summer recharge and declines during the remainder of the year. The groundwater flow direction generally mimics surface topography and the weathered bedrock surface. Groundwater flow modeling indicates that most, if not all, saturated zone groundwater within the UHSU is discharged to the surface at the Present Landfill seep. Present Landfill seep discharge is first treated and then flows into the East Landfill Pond. The dam located east of the East Landfill Pond significantly limits further downgradient migration of water from the surface.

Local impacts to hydraulic gradients are expected because the cover will reduce surface water infiltration. The cover will cause an increase in surface water flows after storm events as the water is shed laterally, rather than infiltrating the surface. Surface water drainage ditches will divert stormwater runoff around the landfill, resulting in further reduction of surface infiltration and groundwater recharge through the fill.

The cover will provide an overall positive impact to groundwater in that it will reduce the amount of precipitation that is infiltrated into and through the landfill. As a result, less leachate will be generated at the landfill and less groundwater mixed with leachate will discharge to the surface at the Present Landfill seep. No significant impact to groundwater quality is expected from the remedial action, given that no significant impact to downgradient groundwater quality is currently observed.

7.4 Impacts to Wildlife Vegetation

Cover construction activities at the Present Landfill may temporarily affect vegetation communities and wildlife habitat in and around the area. Temporary effects due to surface disturbance associated with cover construction and noise associated with heavy equipment are expected.

Approximately 25 acres will be affected by construction activities, which will include the landfill cover construction (23 acres), and miscellaneous activities, including the construction of a staging area (2 acres). Borrow area and staging area sites may be located in mid-grass prairie vegetation communities that currently contain a mixture of native and non-native plants. Revegetation of areas will include native prairie species.

The period of increased equipment noise, vehicular traffic, and other human activity will last less than one year. During this time, sensitive wildlife species may avoid the area. The area affected is highly variable and dependent on species and individuals. Some animals may habituate to the activity and return to the area. Although wildlife use of the area may be reduced because of this avoidance response, the drainage area of the Present Landfill does not represent critical habitat or breeding areas for Site wildlife.

Long-term impacts on ecological resources will include physical alteration of terrestrial habitats. Physical alteration of the habitats will include degradation and/or permanent loss of existing habitat. The primary areas involved are mid-grass prairie in the borrow and staging sites, and the mid-grass prairie immediately surrounding the landfill and East Landfill Pond. The wetland and aquatic habitats associated with the pond, and the riparian/grassland areas immediately east of the pond, will not be impacted.

As noted previously, the potential borrow area and staging area sites represent only a temporary loss of habitat because they will be revegetated with native species after completion of the landfill cover. Therefore, potential impacts to wildlife and vegetation during implementation of the proposed action will not be significant.

The proposed Present Landfill cover will result in a temporary loss of habitat over approximately 23 acres; however, the amount of habitat lost to the cover is a small fraction of the overall amount of habitat available in the region.

7.5 Impacts to Transportation

The proposed action will only slightly impact both on-site and off-site transportation systems. Increased on-site truck traffic will be an inconvenience; however, safety risks will be low and impacts will be mitigated by very low and closely observed speed limits. In comparison analyses in the CID (DOE 1997), off-site traffic impacts will not increase substantially. Therefore, potential impacts to transportation from the proposed action will not be significant.

7.3 Impacts to Cultural and Historic Resources

The Rocky Flats Plant site was placed on the National Register of Historic Places as a Historic District (5JF1227) on May 19, 1997. Historic District designation mandates compliance with the Historic Preservation Act of 1966, and the Programmatic Agreement among DOE, the Colorado State Historic Preservation Officer, and the Advisory Council on Historic Preservation Regarding Historic Properties at RFETS. While the remedial action will be conducted within the Historic District boundaries, no impact will occur to protected structures.

7.6 Impacts to Visual Resources

During installation of the cover, bulldozers and other equipment may be visible from off-site locations. Dust generated during earthmoving operations may be temporarily visible, but will dissipate and will not leave the Site as a visible cloud or plume of dust. Control measures, such as watering, will be used if needed to control dust. Therefore, potential impacts to visual resources during implementation of the proposed action will not be significant. The RCRA Subtitle C-compliant cover will not present a long-term impact to visual resources because it will be vegetated with native prairie grasses.

7.7 Noise Impacts

Noise levels may be elevated during construction of the cover. These levels will not exceed those commonly encountered at a highway construction site. Appropriate hearing protection will be supplied to project personnel as identified in the project-specific HASP. Therefore, potential noise impacts from the proposed action will not be significant.

7.8 Cumulative Impacts

The proposed action supports the overall mission to clean up RFETS and make it safe for future uses. The cumulative effects of this broad, Sitewide effort are presented in the CID (DOE 1997) and 2000 CID Update Report (DOE 2001), which describe the short- and long-term effects from the overall cleanup mission.

The primary focus of the CID (DOE 1997) is on cumulative impacts resulting from on-site activities conducted during Site closure. Cumulative impacts result from the effects of Site closure activities and other actions taken during the same time in the same geographic area, including off-site activities, regardless of what agency or person undertakes such other action. The analysis contained in the 2000 CID Update Report (DOE 2001) includes updated on-site and off-site transportation activities, as well as several new off-site activities, although the future non-DOE projects are relatively uncertain. Increased traffic congestion will be the most noticeable impact according to the 2000 CID Update Report (DOE 2001), resulting from increased RFETS traffic and other planned or proposed construction projects near RFETS. Air pollutants and noise will also have adverse impacts; however, the impacts are expected to be short-term in nature, with staggered project start and completion dates.

The cumulative impacts of the proposed action are expected to be similar to those analyzed in the CID (DOE 1997) and 2000 CID Update Report (DOE 2001). Over the short term, additional construction personnel will have an additive effect on the existing workload for Site operations, and there will be increased air emissions, visual impacts, noise, and traffic impacts resulting from construction activities. These short-term impacts will be minimal. Long-term impacts (i.e., Present Landfill cover construction activities in conjunction with other ER work and facility decommissioning activities) facilitate future use of the Site and fulfill the mandated cleanup objectives.

7.4 Irreversible and Irretrievable Commitment of Resources

The proposed action will result in a variety of permanent commitments of resources; however, it is not expected to result in a substantial loss of valuable resources. Most of the resources used for construction of the cover are permanently committed to implementation of the remedial action. Irreversible and irretrievable resources are defined as resources that are either consumed, committed, or lost. At the Present Landfill, irreversible and irretrievable resources include the following:

- Consumptive use of geological resources (e.g., quarried rock, soil, and gravel for road construction) will be required for construction activities. Supplies of these materials will be provided by an on-site or off-site commercial borrow source. The proposed action requires a permanent commitment of a RCRA Subtitle C-compliant cover to construct the Present Landfill cover. However, adequate supplies are available without affecting local demand for these products.

- Materials for the construction of the geosynthetic composite liner will be required; however, adequate supplies are available without affecting local or national demand for these products.

- Fuel consumed by construction equipment and vehicles used for the construction of the Present Landfill cover will not be recovered.

- Resources that are accessible by excavation or drilling within the cover and that underlie the Present Landfill will be lost.

- The commitment of up to 23 acres of land as a landfill permanently commits and constrains the area to limited land-use options.

- Wetlands and associated natural resources will not be reduced at the Present Landfill. Long-term direct impacts to the floodplain resulting in changes of flood elevations will not occur.

- A long-term commitment of personnel and funds will be required to perform post-closure inspection, maintenance, and monitoring activities.

- Commercial, industrial, and residential land uses are permanently prohibited within boundaries of the Present Landfill due to construction of the cover and the network of monitoring wells. Groundwater use will also be prohibited.

- Incidental resources that are consumed, committed, or lost on a temporary and/or partial basis during construction include construction personnel and equipment, the construction water source, and some construction materials for staging and access.

- Monitoring and maintenance activities will be performed, as necessary, to ensure long-term protection of human health and the environment.

8.0 IMPLEMENTATION SCHEDULE

It is anticipated that the accelerated action will be implemented during FY04.

9.0 CLOSEOUT REPORT

Upon completion of cover construction activities at the Present Landfill, a Closeout Report will be prepared in accordance with RFCA to address cover construction. The Closeout Report will document the work completed within the scope of this IM/IRA. The expected outline for the Closeout Report is as follows:

- Introduction;
- Construction description;
- Dates and duration of specific activities (approximate);
- Deviations from the decision document;
- Description of unit closure activities;
- Demarcation of wastes left in place (i.e., survey bench marks and measurements);
- Demarcation of areas requiring access controls;
- Construction photographs; and
- Results of QA/QC testing and inspections.

The closeout report will include the cover certification report prepared by an independent licensed Professional Engineer.

Upon completion, the Closeout Report will be submitted for review and approval by CDPHE and EPA, and placed in the AR File.

10.0ADMINISTRATIVE RECORD

The AR File will contain the Present Landfill IM/IRA, including scoping meeting minutes, unit-specific information for RCRA-regulated units undergoing closure, and the Final Closeout Report for the project. In addition, project-specific information, such as project correspondence, work control documents, and other information generated as a direct result of this project, will be filed in the Project Record.. The Project Record files will be transferred to Site Records Management upon completion of the Final Closeout Report.

11.0RESPONSIVENESS SUMMARY

Responses to comments received during the formal public comment period, including comments from the regulatory agencies, are documented in Appendix G.

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Appendix A

Post-Accelerated Action Monitoring and Long Term Stewardship Considerations

POST-ACCELERATED ACTION MONITORING AND LONG-TERM STEWARDSHIP CONSIDERATIONS

The objective of this section is to identify post-accelerated action monitoring and post-closure care (that is, long-term stewardship) requirements of the proposed accelerated action for the Present Landfill. These requirements are necessary for the long-term effectiveness of this remedy and include the following components: compliance with the Colorado Hazardous Waste Act (CHWA) post-closure requirements of 6 Colorado Code of Regulations (CCR) 1007-3, Part 265; information management; periodic review; and administrative jurisdiction. Other requirements necessary for the short- and long-term effectiveness of the remedy are identified in this Appendix, including institutional controls, inspection and maintenance, and environmental monitoring. These requirements are specific to the accelerated actions described in this IM/IRA and are summarized in Table 1. Additionally, these requirements will ultimately be captured (along with post-closure care requirements from other accelerated actions at Rocky Flats) in post-closure regulatory documents, which may include the final Corrective Action Decision/Record of Decision (CAD/ROD) for Rocky Flats, any post-closure Rocky Flats Cleanup Agreement (RFCA)-type agreement, and any post-closure Resource Conservation and Recovery Act (RCRA) permit (or other enforceable mechanism). DOE and CDPHE have not reached agreement as to whether a post-closure permit or, alternatively, an enforceable document as defined in 6 CCR 1007-3, Section 100.10(d) will be required for Rocky Flats, and if so, what requirements that permit or enforceable document will contain. The Parties will endeavor to resolve this matter. Failing an agreed-upon solution, each Party reserves its rights as provided in RFCA Part 18. Further, absent resolution of this matter consistent with the State Covenants Law, the CDPHE reserves the right to require a post-closure permit.

1.0 RCRA/CHWA POST-CLOSURE CARE REQUIREMENTS

Post-closure controls, monitoring, and maintenance requirements for the cover described in this Appendix will be implemented at the Present Landfill. Some of these requirements are also the subject of an environmental covenant for the site if it is determined that Colorado's law applies to the federal government (see Section 25-15-320, C.R.S.).

The RFCA Parties have not reached agreement on the applicability of the statute to the federal government. Failing an agreed-upon resolution, each Party reserves its rights as provided in RFCA Part 18. 6 CCR 1007-3 Part 265.310(b) details the maintenance and monitoring requirements that must be implemented throughout the post-closure care period. The regulations establish 30 years as the default post-closure care period. However, the Colorado Department of Public Health and Environment (CDPHE) has the authority to increase or decrease this time period, as appropriate. The following requirements will be imposed in the post-closure permit or other enforceable mechanisms implemented for the Present Landfill:

- Maintain the integrity and effectiveness of the final cover, including making repairs to the cover as necessary to correct the effects of settling, subsidence, erosion, or other events;

- Maintain and monitor the groundwater monitoring system and comply with all other appropriate requirements; and
- Prevent runon and runoff from eroding or otherwise damaging the final cover.

Each of these three requirements is discussed further below.

1.1 Maintain Integrity and Effectiveness of the Final Cover

Current Sitewide security and access controls will be maintained until completion of the Rocky Flats Environment Technology Site (RFETS or Site) Closure Project. Additional institutional controls related to maintaining the integrity and effectiveness of the final cover are identified in the IM/IRA and summarized in Table 1.

Following construction of the cover, monitoring and maintenance activities will be performed quarterly. The cover will be inspected for signs of erosion, differential settling, subsidence, burrowing animals, weeds, and seepage areas. Signs of potential problems include, but are not limited to, deep rooting vegetation (trees), ponded water on the surface, and surface depressions.

Routine maintenance of the cover will include filling in and regrading any depressions, burrowing animal holes, or other disturbances. Where excessive erosion has occurred, soil will be replaced with similar cover soil and revegetated. After restoration of the cover, the area prone to excessive erosion will be protected further with structural erosion controls such as erosion mats, silt fences, straw-bale sediment barriers, and straw-bale check dams. These controls will be installed and maintained as necessary to limit sediment transport.

Special attention will be provided on the east-facing slope of the landfill to monitor for any sloughing or movement of the side slope.

Repairs and routine maintenance will be made to maintain the integrity and effectiveness of the cover. Inspection results, repairs, and routine maintenance will be documented in annual reports to the regulatory agencies and may be combined with future Sitewide maintenance and monitoring reports.

1.2 Maintain and Monitor the Groundwater Monitoring System

A groundwater monitoring system (6 CCR 1007-3, 265.90[d]) was implemented under the Integrated Monitoring Plan (IMP) and has monitored downgradient groundwater quality for impacts from the landfill. A total of eight (four upgradient and four downgradient) RCRA groundwater monitoring wells have been established for the Present Landfill pursuant to RFCA and RCRA. The effects of the new cover including changes in surface water and groundwater flow may occur which could impact the groundwater quality. The constituents that will be monitored are volatile organic compounds (VOCs) and metals. The purpose of this monitoring is to evaluate upgradient versus downgradient groundwater quality at the Present Landfill. Groundwater sampling results will be evaluated in accordance with RFCA Attachment 5, Section 3.0.

1.3 Prevent Runon and Runoff From Eroding or Damaging the Cover

The landfill cover will be graded to allow positive surface water drainage (slopes of 3 percent to 5 percent) into perimeter drainage ditches that will collect and direct surface water flow from both inside and outside the landfill footprint. Erosion of the cover from storm or wind events is extremely unlikely but will be monitored as part of the routine inspections of the cover. In addition, water that infiltrates the soil layer of the composite cover will be removed by the composite drainage layer above the flexible membrane liner (FML) and flow into the perimeter drainage ditches. This will prevent a build-up of water over the FML.

Following construction of the cover, inspection and maintenance activities of the perimeter drainage ditches will be performed quarterly. The perimeter drainage ditches will be visually inspected for signs of erosion and weeds. Routine maintenance, as necessary, includes repairing areas with soil erosion blankets and reseeding.

Routine maintenance will be conducted to prevent runon and runoff from eroding or damaging the cover. Inspection results, repairs, and routine maintenance will be documented in annual reports to the regulatory agencies and may be combined with future Sitewide maintenance and monitoring reports.

2.0 LANDFILL SEEP MONITORING

The landfill seep will be monitored at the influent to the treatment system and at the National Pollutant Discharge Elimination System (NPDES) outfall (treatment system effluent). The parameters that will be monitored are VOCs and metals. The effluent limits for the treatment system effluent are the surface water standards applicable for the receiving water as listed in RFCA Attachment 5, Table 1. After the cover is installed, monitoring of the influent and effluent of the treatment system will be conducted quarterly until the first Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) review. A validated exceedance of an effluent limit will trigger an increase in monitoring to monthly for three consecutive months. Continued exceedances during the three-month period will trigger consultation between the RFCA parties to evaluate whether a change to the remedy is required, additional parameters need to be analyzed, or a different sampling frequency is required. If no exceedances are detected during the first CERCLA review period, then the monitoring frequency will change from quarterly to either semiannually or annually based on the review of the data by the RFCA parties.

During the sampling period, a validated exceedance of an effluent limit will trigger an increase in monitoring to monthly for three consecutive months. Continued exceedances during the three-month period will trigger consultation between the RFCA parties to evaluate whether a change to the remedy is required, additional parameters need to be analyzed, or a different sampling frequency is required. During future CERCLA periodic reviews, the RFCA parties will evaluate whether continued monitoring of the treatment system effluent is required beyond the yearly sampling required under the existing law.

3.0 EAST LANDFILL POND MONITORING

If the effluent of the seep treatment system continues to exceed the effluent limits established in Section 2.0, water in the East Landfill Pond will be sampled for the constituents that have been exceeded in the seep treatment system effluent. If the water in the East Landfill Pond exceeds the surface water standards applicable for the receiving water as listed in RFCA Attachment 5, Table 1, the RFCA parties will be consulted to determine if further monitoring is required, if the water in the pond can be allowed to overflow through the existing spillway at the East landfill Pond, or some other water management strategy should be implemented.

4.0 INSTITUTIONAL CONTROLS

Institutional controls include administrative controls such as use restrictions, and are intended to prevent or limit adverse exposure to residual contamination, and/or limit access to a site to ensure the ongoing security and effectiveness of facilities such as engineered controls or monitoring devices. Physical controls that restrict access to the site are included as a subset of institutional controls. General and specific post-accelerated action institutional controls for RFETS as a whole are currently being evaluated by the U.S. Department of Energy (DOE) and the regulatory agencies, and in consultation with the U.S. Fish and Wildlife Service (USFWS), and the community.

The institutional controls that will be implemented at the Present Landfill for this proposed action are described below. Controls described in Items 3 through 9 will be included in the post-closure permit or other enforceable mechanism for the Present Landfill. The RFCA parties have not resolved whether the federal government is required to comply with Colorado's SB01-145. If it is determined that Colorado's SB01-145 does apply to federal agencies, an environmental covenant will be required for the Present Landfill, and the controls described in Items 3 through 9 will also be included in such a covenant. The Present Landfill controls are as follows:

1. Current Sitewide security and access controls will be maintained until completion of the RFETS Closure Project, currently scheduled for December 2006, but will be replaced by equivalent controls for the Present Landfill and other specific areas for which security and access controls are required.

2. In accordance with the Rocky Flats Wildlife Refuge Act of 2001 (Pub.L. 107-107, Sec. 3171-3182, [December 28, 2001]), DOE will retain jurisdiction over the engineered controls associated with the proposed action.

3. Prohibitions on drilling and pumping of groundwater wells for uses other than the remedy will be established.

4. Prohibitions on the use and excavation of the cover and of the area in the immediate vicinity of the cover will be established.

5. Prohibitions on drilling on and in the immediate vicinity of the cover will be established.

6. Prohibitions on disruption of the seep and the passive seep interception and treatment system until it is determined that the system is no longer need be established.

7. To avoid adverse impacts, roads and trails will not be allowed on the cover or the immediate vicinity of the cover. Signs may be erected that indicate vehicles are prohibited from specific areas and that direct vehicle traffic appropriately. A determination will be made during project construction as to whether signs or fences will be used as the preferred means of restricting access.

8. Upon construction completion, fencing around the cover, or specific locations on or around the cover, may also be considered to limit the potential for damage or tampering with the location. Signs and markers may be used as controls to delineate the landfill boundary; outline digging, fishing, swimming, groundwater, and surface use restrictions; and/or describe access restrictions to the landfill cover and monitoring locations for the cover.

9. Inspection of these institutional controls will be performed quarterly to determine their continuing effectiveness. Results of these inspections will be reported annually.

5.0 CERCLA FIVE-YEAR REVIEW

In accordance with CERCLA, a review of the remedy remaining protective of human health and the environment will be conducted periodically, at least every five years.

6.0 INFORMATION MANAGEMENT

A successful stewardship program is dependent on retaining the necessary records about the history and residual contamination of the site. Retained information should include the history of the site, the contaminants of concern (COCs), the selected remedies, the use of controls and their associated monitoring and maintenance records, and any other information judged necessary for succeeding generations to understand the nature and extent of the residual contamination. At a minimum, the following records will be retained, stored, and retrievable for this accelerated action:

- This IM/IRA and any future modifications;
- The final design for the cover and field change requests;
- The as-built drawings of the cover;
- The monitoring and maintenance manual and subsequent revisions;
- Inspection records and logbooks;
- Maintenance records and logbooks;
- Annual performance assessment reports;
- Analytical data;

Table 1. Summary of Present Landfill Post-Accelerated Action Monitoring, Maintenance, and Institutional Control Requirements

Area	Action	Frequency of Action	Criteria	Possible Follow-on Action
Cover	Visual Inspection	Quarterly	Differential settling/ subsidence	Repair as necessary.
			Erosion	Repair erosion areas with soil and revegetate as necessary.
			Unwanted vegetation	Remove deep rooting trees or employ weed control measures, as necessary.
			Burrowing animals	Remove animals and repair damage as necessary.
Perimeter Drainage Ditches	Visual Inspection	Quarterly	Erosion	Repair erosion areas with soil, erosion blankets, and revegetation as necessary.
			Unwanted vegetation	Remove deep rooting trees or employ weed control measures as necessary.
Landfill Seep	Sampling, influent and effluent of the passive treatment system	Quarterly	Analyze for VOCs and metals. Effluent limitations are the surface water standards (RFCA Attachment 5, Table 1)	If a surface water standard is exceeded, sampling will increase to monthly for three consecutive months. If exceedances continue, the RFCA parties will consult to determine whether a change in the remedy is required, additional parameters need to be analyzed; or a different sampling frequency is required.
Passive seep interception and treatment system	Visual Inspection	Quarterly	System components	Repair as necessary.

Area	Action	Frequency of Action	Criteria	Possible Follow-on Action
			Unwanted vegetation	Employ weed control measures as necessary.
			Erosion	Repair erosion areas with soil and revegetation as necessary.
East Landfill Pond	Water Sampling	Only if seep treatment effluent exceeds effluent limits for more than three consecutive months	Sample only for constituents that exceeded the seep treatment system effluent limits	If results indicate that water concentrations in the East Landfill Pond are below the surface water standards (RFCA Attachment 5, Table 1), no action is necessary. If the results indicate that concentrations in the East Landfill Pond are above the surface water standards, the RFCA parties will be consulted to determine if further sampling is required, if the water in the pond can overflow the East Landfill Pond dam from the existing spillway , or another water management strategy should be applied.
Groundwater	Sampling	Quarterly	Increasing trend in VOCs and metals in downgradient versus upgradient RCRA groundwater monitoring wells	Statistically significant changes in downgradient versus upgradient groundwater quality and a statistically significant increasing trend will require consultation between the RFCA parties to determine if changes to the remedy are required.
Institutional and Physical Controls	Visual inspection	Quarterly	Security and access controls; and overall Site conditions	Check signs, markers, and the overall condition of the Present Landfill site to determine continuing effectiveness of institutional and physical controls.

- CERCLA five-year review reports;
- Correspondence between the agencies associated with modifications to the post-closure care regime;
- The Memorandum of Understanding (MOU) between DOE and the U.S. Department of Interior (DOI) (identifying the controlling authority);
- The CAD/ROD; and
- The RFETS Historical Release Reports (HRRs) and other relevant historical documentation.

This information will be maintained in the Administrative Record (AR) File. Currently, the AR File is maintained on site. DOE is currently looking at options for retention of permanent records following Site closure.

7.0 CONTROLLING AUTHORITY

Long-term protection of human health and the environment necessitates that a controlling authority be established with responsibility for post-closure management. CERCLA mandates that DOE, as a responsible party, will retain responsibility for the contamination at RFETS resulting from its activities there, as well as responsibility for long-term maintenance of any remedies. The Rocky Flats National Wildlife Act of 2001 requires that, following certification by U.S. Environmental Protection Agency (EPA) that the cleanup and closure of Rocky Flats has been completed, certain lands of the current Site will be transferred from the Secretary of Energy to the Secretary of the Interior. These lands would be under administrative jurisdiction of the USFWS. The Act also requires the Secretary of Energy to retain administrative jurisdiction over certain real property and facilities, including engineered structures required to carry out response actions required for the cleanup and closure of the Site. The MOU currently being negotiated between DOE and DOI will outline this process, although it is unlikely the final boundaries of the land to be transferred will be determined until the final cleanup and closure plans are approved. However, the Present Landfill cover identified in Section 5.0 as the proposed action is an engineered structure and thus, will remain under the administrative jurisdiction of the Secretary of Energy.

8.0 REPORTING REQUIREMENTS

Annual reporting to include data results, inspection results, repairs, and routine maintenance will be required. These reporting requirements may be combined into one report and possibly with future Sitewide maintenance and monitoring reports.

Parameter ID	Parameter Name
ORGANICS	
	Target Analytes
67-64-1	Acetone
71-43-2	Benzene
108-86-1	Bromobenzene
74-97-5	Bromochloromethane
75-27-4	Bromodichloromethane
75-25-2	Bromoform
74-83-9	Bromomethane
78-93-3	2-Butanone (MEK)
104-51-8	n-Butylbenzene
135-98-8	sec-Butylbenzene
98-06-6	tert-Butylbenzene
75-15-0	Carbon Disulfide
56-23-5	Carbon Tetrachloride
108-90-7	Chlorobenzene
75-00-3	Chloroethane
67-66-3	Chloroform
74-87-3	Chloromethane
95-49-8	2-Chlorotoluene
106-43-4	4-Chlorotoluene
96-12-8	1,2-Dibromo-3-chloropropane
124-48-1	Dibromochloromethane
106-93-4	1,2-Dibromomethane (EDB)
74-95-3	Dibromomethane
95-50-1	1,2-Dichlorobenzene
541-73-1	1,3-Dichlorobenzene
106-46-7	1,4-Dichlorobenzene
75-71-8	Dichlorodifluoromethane
75-34-3	1,1-Dichloroethane
107-06-2	1,2-Dichloroethane
75-35-4	1,1-Dichloroethylene
156-59-2	cis-1,2-Dichloroethylene
156-60-5	trans-1,2-Dichloroethylene
78-87-5	1,2-Dichloropropane
142-28-9	1,3-Dichloropropane
594-20-7	2,2-Dichloropropane
563-58-6	1,1-Dichloropropene
10061-01-5	cis-1,3-Dichloropropene
10061-02-6	trans-1,3-Dichloropropene
100-41-4	Ethyl Benzene
87-68-3	Hexachlorobutadiene
591-78-6	2-Hexanone
98-82-8	Isopropylbenzene

Parameter ID	Parameter Name
99-87-6	p-Isopropyltoluene
108-10-1	4-Methyl-2-pentanone (MIBK)
75-09-2	Methylene Chloride
91-20-3	Napthalene
103-65-1	n-Propylbenzene
100-42-5	Styrene
630-20-6	1,1,1,2-Tetrachloroethane
79-34-5	1,1,2,2-Tetrachloroethane
127-18-4	Tetrachloroethylene
108-88-3	Toluene
87-61-6	1,2,3-Trichlorobenzene
120-82-1	1,2,4-Trichlorobenzene
71-55-6	1,1,1-Trichloroethane
79-00-5	1,1,2-Trichloroethane
79-01-6	Trichloroethylene
75-69-4	Trichlorofluoromethane
96-18-4	1,2,3-Trichloropropane
76-13-1	1,1,2-Trichlorotrifluoroethane
95-63-6	1,2,4-Trimethylbenzene
108-67-8	1,3,5-Trimethylbenzene
75-01-4	Vinyl Chloride
1330-20-7	Xylenes
INORGANICS	
	Metals
7429-90-5	Aluminum
7440-36-0	Antimony
7440-38-2	Arsenic
7440-39-3	Barium
7440-41-7	Beryllium
7440-43-9	Cadmium
7440-70-2	Calcium
7440-47-3	Chromium
7440-48-4	Cobalt
7440-50-8	Copper
7439-89-6	Iron
7439-92-1	Lead
7439-93-2	Lithium
7439-95-4	Magnesium
7439-96-5	Manganese
7439-97-6	Mercury
7439-98-7	Molybdenum
7440-02-0	Nickel
7440-09-7	Potassium
7782-49-2	Selenium

Parameter ID	Parameter Name
7440-22-4	Silver
7440-23-5	Sodium
7440-24-6	Strontium
7440-28-0	Thallium
7440-31-5	Tin
11-09-6	Uranium
7440-62-2	Vanadium
7440-66-6	Zinc

Appendix B
Groundwater Monitoring Summary for the Present Landfill

GROUNDWATER MONITORING SUMMARY FOR THE PRESENT LANDFILL

Year	Regulatory Driver	Monitor Well Network	Analytical Program	Findings	Comments
1986	• 1896 RCRA Compliance Order and CERCLA Agreement • DOE CEARP • 6 CCR 1007-3, Part 265, Subpart F	4 Wells total: • 2 Upgradient (one alluvial; one bedrock) • 2 Downgradient at toe of the landfill (one alluvial; one bedrock)	Sampled quarterly: • HSL VOCs, SVOCs, and metals • Other major ions. • Radionuclides	No formal data evaluation conducted yet.	Results included in the 1989 RCRA Annual Groundwater Monitoring Report
1987	Same as 1986	20 wells total: • additional wells were located upgradient, downgradient of the landfill pond, and near the north and south perimeter	Sampled quarterly: • HSL VOCs, SVOCs, pesticides, PCBs, and metals; • Other major ions. • Field Parameters • TDS • Oil and Grease • Radionuclides	No formal data evaluation conducted yet.	Results included in the 1989 RCRA Annual Groundwater Monitoring Report
1988	• Same as 1986 • Begin alternate monitoring program per 6 CCR 1007-3, Part 265.90(d) • Annual reporting per 265.93(d)(4)	35 wells total: • additional wells were located in and around the landfill	Same as 1987	• Downgradient alluvial GW has elevated major ions, Fe, Mn, Sr, Ba. Concentrations were either lower than background concentrations or lower than groundwater concentrations detected within the landfill. • High salts further downgradient in alluvial GW conjectured to be from an unidentified natural source • High salts in bedrock GW conjectured to be due to mineral dissolution because it is not present in alluvial GW in the landfill	Results included in the 1989 RCRA Annual Groundwater Monitoring Report
1989	Same as 1988 • Monitoring also done in compliance with 6 CCR 1007-2.	Same as 1988	Same as 1987	Similar to 1988.	• Results discussed in the 1991 RCRA Annual Groundwater Monitoring Report • Results also included in 1996 Groundwater Monitoring Report for the Present Sanitary Landfill
1990	Same as 1988	Same as 1988	Same as 1987	Groundwater quality within the landfill indicated concentrations of major ions, dissolved metals, dissolved radionuclides and VOCs to shallow groundwater. VOCs were detected sporadically and infrequently in wells screened in surficial materials during 1990. High salt concentrations downgradient of the landfill were considered to result from an unidentified and presumably natural source. Concentrations of major ions observed in bedrock wells were typically higher than concentrations seen in alluvial groundwater within the landfill.	• Results included in the 1992 RCRA Annual Groundwater Monitoring Report • Results also included in 1996 Groundwater Monitoring Report for the Present Sanitary Landfill
1991	• Interagency Agreement (IAG) • Alternate monitoring program per 6 CCR 1007-3, Part 265.90(d) • Annual reporting	Same as 1988	Same as 1987	Bicarbonate, fluoride, chloride, magnesium, sodium, calcium, dissolved silica, TDS, pH and specific conductance had statistically significant difference between upgradient and downgradient groundwater quality. The Present Landfill does not appear to impact downgradient groundwater quality with respect to VOCs and radionuclides.	• Results included in the 1992 RCRA Annual Groundwater Monitoring Report • Results also included in 1996 Groundwater Monitoring Report for the Present Sanitary Landfill • The IAG does not change RFETS GW monitoring program

Year	Regulatory Driver	Monitor Well Network	Analytical Program	Findings	Comments
	per 265.93(d)(4)				
1992	Same as 1988	Same as 1988	Same as 1987	• Alluvial GW within and around the landfill has elevated concentration of major anions. Concentrations of major ions observed in groundwater from the UHSU and LHSU bedrock wells were typically higher than concentrations observed in groundwater within the landfill. • Same conjecture as 1988 regarding high salts in bedrock GW. • Metals and radionuclides are rarely greater than background. • Some detection of VOCs in alluvial GW within the landfill; very infrequent detections in the UHSU bedrock GW. • Groundwater quality in downgradient geologic materials and in weathered bedrock beneath the landfill appears unaffected by the Present Landfill with respect to VOCs, radionuclides, most metals and other inorganic ions.	• Results included in the 1993 RCRA Annual Groundwater Monitoring Report • Results also included in 1996 Groundwater Monitoring Report for the Present Sanitary Landfill and the draft Phase I IM/IRA and Closure Plan (1996) • Begin Present Landfill Phase I RFI/RI
1993	Same as 1992	55 Wells total: • 49 active wells and 6 abandoned (in 1993). • 27 wells are considered RCRA monitor wells • Other wells are for OU 6, 7, and 16 RFI/RIs.	Same as 1987	• GW quality generally consistent with 1992 findings • Statistically significant increase in downgradient UHSU GW for Ca, Li, Mg, K, Na, Sr, and major anions, but not for VOCs and radionuclides. Concentrations of dissolved metals were only rarely greater than sitewide background concentrations. The concentrations of major ions from UHSU and LHSU bedrock wells were typically higher than concentrations observed from groundwater within the landfill. As a result, bedrock groundwater quality was considered to be influenced primarily by mineral dissolution within the sandstone and claystone units. • Same conjecture as 1988 regarding bedrock GW. • Highest concentrations of radionuclides, metals, VOCs, and anions are within the landfill and adjacent to IHSS SE of the landfill	• Results included in the 1994 RCRA Annual Groundwater Monitoring Report • Results also included in 1996 Groundwater Monitoring Report for the Present Sanitary Landfill and the draft Phase I IM/IRA and Closure Plan (1996) • End of Present Landfill Phase 1 RFI/RI
1994	Same as 1993	52 Wells total: • 3 downgradient wells added to monitor alluvial, UHSU bedrock, and LHSU bedrock	Sampled Quarterly: • Field Parameters • TDS, TCC, TSS, pH • TAL Metals plus Cs, Li, Mo, Sr, Sn • Anions • TAL VOCs • Radionuclides • Dioxins/Furans	• GW quality generally consistent with 1993 findings • Statistically significant increase in downgradient UHSU GW for Ca, Li, Mg,, Na, Sr, major anions, and TDS but not for VOCs • One downgradient well shows other inorgamic parameters and radionuclides at concentrations statistically greater than upgradient. Overall, U-233/234 and tritium were showing decreasing trends downgradient of the landfill since 1990/91 (Although prior to RFCA, concentrations were near RFCA Tier II action levels at this time.) • Same observation of location of highest analyte concentrations as in 1993	• Results included in the 1995 RCRA Annual Groundwater Monitoring Report • Results also included in 1996 Groundwater Monitoring Report for the Present Sanitary Landfill and the draft Phase I IM/IRA and Closure Plan (1996) • Begin Present Landfill Phase II RFI/RI
1995	Same as 1994	25 Wells total: • The 27 interior landfill wells were abandoned with permission from CDPHE in letter dated 2/13/95. Wells were	Sampled Quarterly • Field Parameters • TDS, TOC, TSS, pH • TAL metals plus Cs, Li, Mo, Sr, Sn • Anions	• GW quality generally consistent with 1993 findings • Statistically significant increase in downgradient UHSU GW for Ba, Ca, Li, Mg,, Si, Na, Sr, U-233/234, major anions, and TDS but not for VOCs. (Although prior to RFCA, all these analytes were at concentrations less than	• Results included in the 1996 RFCA Annual Groundwater Monitoring Report • Results also included in 1996 Groundwater Monitoring Report for the Present Sanitary Landfill • End Present Landfill Phase II RFI/RI (report not

Year	Regulatory Driver	Monitor Well Network	Analytical Program	Findings	Comments
		abandoned in preparation for constructing a cover.	• TAL VOCs • Dissolved and total radionuclides • Select dioxins and furans	RFCA Tier II Als.)	written due to reallocation of resources because of lower priority placed on Present Landfill relative to other sites) • In May 1995, a well evaluation project was undertaken at RFETS to continue the assessment of the sitewide groundwater monitoring network. A working group devised a new monitoring network based on Data Quality Objectives (DQOs).
1996	RFCA and IMP pursuant to RFCA	10 Total Wells in the area of the Present Landfill: • IMP RCRA Monitoring Wells (4 upgradient and 4 downgradient wells in both alluvium and bedrock) • IMP Plume Definition Wells for the PU&D Yard (1 upgradient and 1 downgradient, both alluvial)	Sampled Semi-annually: • Field parameters • Metals • Anions • VOCs • Radionuclides SVOCs were not included in the sampling program as a result of PCOC screening conducted during the IMP data quality objectives process. This was accepted by CDPHE and EPA.	• Data were not reportable in accordance with the IMP (see comments) • Uranium (although elevated) is below background in wells 4087 and 52894 • Nitrate (although elevated) does not show an increasing trend in well B206989 • Some downgradient wells are often dry; and • Concentration of contaminants detected downgradient were all below RFCA Tier II and therefore not reported. • Increasing VOCs in upgradient well 6687 (PU&D Plume Definition well)	• Results included in the 1st and 3rd quarter 1997 RFCA Groundwater Monitoring Report • Data are reportable when the mean downgradient concentrations are significantly (statistically) higher than the mean upgradient concentrations, and the downgradient concentration does not show a statistically significant positive trend with time for any given well.
1997	RFCA and IMP pursuant to RFCA	Same as 1996 except upgradient well 6687 is abandoned and replaced with well 0597	Same as 1996	• Data were not reportable in accordance with the IMP (see 1996 comments) • Uranium (although elevated) is below background. • Nitrate (although elevated) does not show an increasing trend in well B206989 • Fluoride, sulfate, TDS, Ba, Cu, Fe, Li, Mn, Se, Sr, nitrate, and Zn are at statistically significant higher concentrations in some downgradient wells relative to upgradient wells • Some downgradient wells are often dry • Concentration of contaminants detected downgradient were all below RFCA Tier II and therefore not reported. • Increasing VOCs in upgradient well 70393 (PU&D Plume Definition	Results included in the 1998 RFCA Annual Groundwater Monitoring Report
1998	RFCA and IMP pursuant to RFCA	Same as 1997	Same as 1996	• Data were not reportable in accordance with the IMP (see 1996 comments) • Of the three down gradient wells, one was consistently dry and the alluvial well was consistently below RFCA Tier II ALs. • Fluoride, nitrate, sulfate, TDS, As, Cd, Cr, Li, Mn, Se, Sr, Zn, U-233/234, U-235, and U-238 are at statistically significant higher concentrations in some downgradient bedrock wells relative to upgradient bedrock wells. However, trends were generally flat or declining. • Unknown or natural source conjectured for constituents with elevated concentrations downgradient because they are not observed at these concentrations in the seep (SW97) or the landfill pond. • Elevated U-235 concentration in downgradient bedrock well is estimated to be the result from natural sources	Results included in the 1999 RFCA Annual Groundwater Monitoring Report

Year	Regulatory Driver	Monitor Well Network	Analytical Program	Findings	Comments
				present within the bedrock, as it occurs within the background range for this isotope. • Increasing VOCs in upgradient well 70393 (PU&D Plume Definition	
1999	RFCA and IMP pursuant to RFCA	Same as 1997	Sampled Quarterly: • Field parameters • Radionuclides • VOCs • Metals • Major anions.	• Generally consistent with previous findings • Cu, Li, Se, U233/234 and U-238 were reportable in accordance with the IMP (see 1996 comments) • Fluoride, sulfate, TDS, Sb, Cd, Ca, Cu, Li, Mg, Mo, Ni, K, Se, Na, Sr, U-233/234, U-235, and U-238 are at statistically significant higher concentrations in some downgradient bedrock wells relative to upgradient bedrock wells. However, trends were generally flat or declining. • Increasing trends for Cu, Li, Se, U233/234 and U-238; however U isotopes are below background, and for the metals, only Se exceeded the Tier II AL. • Some downgradient wells are often dry.	Results included in the 2000 RFCA Annual Groundwater Monitoring Report
2000	RFCA and IMP pursuant to RFCA	Same as 1997	Same as 1999	• Generally consistent with previous findings • Li, Zn, U233/234 and U-238 were reportable in accordance with the IMP. The maximum Lithium concentration (1750 ug/L) is slightly above the RFCA Tier II AL (730 ug/L) but well below the RFCA Tier I AL (73,000 ug/L). The maximum zinc concentration (66.2 ug/L) is well below the RFCA Tier II AL (11,000 ug/L). Uranium concentrations still remain below background concentrations. • Fluoride, sulfate, TDS, Ca, Cu, Li, Mg, Mo, Ni, Na, Sr, Zn, U-233/234, U-235, and U-238 are at statistically significant higher concentrations in some downgradient bedrock wells relative to upgradient bedrock wells. • Increasing trends for fluoride, sulfate Li, Zn, U233/234 and U-238. The mean fluoride downgradient concentration (2.02 mg/L) is below the RFCA Tier II AL (4.0 mg/L). The mean sulfate downgradient concentration (1404 mg/L) is slightly above the RFCA Tier II AL (500 mg/L) but well below the RFCA Tier I AL (50,000 mg/L).	Results included in the 2001 RFCA Annual Groundwater Monitoring Report
2001	RFCA and IMP pursuant to RFCA	Same as 1997	Same as 1999	• Generally consistent with previous findings • V and U233/234 and were reportable in accordance with the IMP. Uranium concentrations still remain below background concentrations. • Sulfate, TDS, Ca, Cu, Li, Mg, Mo, Se, V, U-233/234, U-235, and U-238 are at statistically significant higher concentrations in some downgradient bedrock wells relative to upgradient bedrock wells. • Increasing trends only for V and Zn. The mean Zn concentration (7.21 ug/L) is below the RFCA Tier II AL (11,000 ug/L). The mean V concentration (1.24 ug/L), although increasing in concentration, was "B" qualified and is below the RFCA Tier II AL (256 ug/L).	Results included in the 2002 RFCA Annual Groundwater Monitoring Report

Appendix C

Integrated Hydrologic Model for the Present Landfill at the Rocky Flats Environmental Technology Site

Integrated Hydrologic Model for the Present Landfill at the Rocky Flats Environmental Technology Site

April 2003

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1.0 INTRODUCTION

This report summarizes development of an integrated hydrologic flow model for the Present Landfill at Rocky Flats Environment Technology Site (RFETS or Site). In this section, the purpose of the study is presented first in Section 1.1, followed by the study scope in Section 1.2, and finally the organization of the report in Section 1.3.

1.1 Purpose

The purpose of this study was to develop an integrated hydrologic flow model that can be used to better understand the surface and subsurface flow in the Present Landfill area. There are many benefits of developing an integrated hydrologic model for the Present Landfill. For example, integrated codes are capable of simulating all of the major landfill features in a physically more realistic fashion than single process codes. Previous modeling efforts in the area relied upon single process codes, like MODFLOW, to simulate only groundwater flows. However, MODFLOW does not simulate surface flows, or unsaturated zone flows, that are important in determining system processes such as groundwater recharge, which are inherently complex and spatially and temporally variable.

The integrated hydrologic model developed in this study produces several types of output that are useful in evaluating system flows. This should improve the understanding of the integrated flow behavior within the landfill system. Some of the key output generated by the integrated model include the following:

- Spatial and temporal distribution of groundwater flow rates and directions (pathways);
- Lateral flows in waste, unconsolidated material, and weathered bedrock;
- Lateral flows in unweathered bedrock;
- Spatial and temporal distribution of water levels in unconsolidated material, and the weathered and unweathered bedrock;
- Temporal variability in key components of the water budget (i.e., evapotranspiration [ET], recharge, snowmelt, surface runoff, groundwater flow, and unsaturated zone flow among others for any specified area); and
- Seepage rates and seep locations.

It should be recognized that the ability of the model to accurately predict any of the above system responses depends on the available data quality and quantity. It also depends on the underlying complexity of the system, which may not necessarily be characterized well using available data.

1.2 SCOPE OF WORK

The modeling study includes three primary objectives outlined below:

- Develop an integrated conceptual and numeric hydrologic model of the Present Landfill flow system;
- Use the model to evaluate current integrated flow conditions, flow magnitudes, and a general water balance for the Present Landfill system; and
- Use the model to simulate hydrologic changes to the system using a hypothetical landfill cover.

The integrated model developed in this study follows the same general approach used to develop the regional Site-Wide Water Balance (SWWB) model (K-H 2002a). Because the Present Landfill model study area is much smaller than in the SWWB model, the underlying numeric grid resolution can be increased substantially. In this model, the mathematical model grid is refined to a 50- by 50-foot size to more accurately simulate smaller features, such as the groundwater intercept system (GWIS).

1.3 Report Organization

The main body of this report summarizes key steps in developing and applying the integrated Present Landfill flow model, namely:

- The study purpose, scope, and report organization are presented in Section 1.0.
- A brief background and study area are presented in Section 2.0.
- Available Site data and their interpretation are presented in Section 3.0.
- The integrated conceptual flow model is presented in Section 4.0.
- The general modeling approach is presented in Section 5.0.
- The numeric model input and design is presented in Section 6.0.
- The integrated numerical model performance is described in Section 7.0 (Model performance includes calibration, validation, and sensitivity analyses).
- Development and results of a hypothetical scenario in which a landfill cover modification is simulated are presented Section 8.0.
- Model development and results are summarized and conclusions aremade in Section 9.0.

2.0 BACKGROUND SITE DESCRIPTION

This section provides a brief description of the Present Landfill area, including physical features and historical operation. The information is taken from previous reports on the study area, emphasizing the Operable Unit (OU) 7. Final Work Plan (DOE 1994) and Draft Phase I Interim Measure/Interim Remedial Action (IM/IRA) Decision Document and Closure Plan (DOE 1996). This background information provides a basis for discussion of the hydrologic conceptual model described in Section 1.0.

2.1 Study area

The Present Landfill is located north of the Industrial Area (IA) on the western end of No Name Gulch (Figure 2-1). The area selected for the modeling is approximately 210 acres in size. The Present Landfill waste area within the modeled area is approximately 20 acres. It is surrounded by natural terrain on the northern and western sides. To the south are features associated with the IA, including the Property Utilization and Disposal (PU&D) Yard. The Landfill Pond is impounded by a dam east of the Present Landfill, and is approximately 2.5 acres in size.

The study area boundary includes all of the features that may impact the interpreted flow in the Present Landfill system. The northern and western boundaries were defined to include the surface water features of McKay and Church Ditches. The southern boundary is the base of the surface water drainage for North Walnut Creek. The eastern model boundary was set east of the landfill pond dam so that flows near the dam and immediately downgradient of the dam in No Name Gulch were included in the model.

Figure 2-1. Present Landfill Study Area - Site Map

(ATTACHED)

2.2 General Features and History

2.2.1 Key Landfill Area Features

Site features that affect system hydrology of the model area are shown on Figure 2-1. The features are briefly described below and in more detail in Section 3.0.

Landfill Trench System

The Landfill Trench System was placed around the northern, western, and southern sides of the Present Landfill in 1974. It was a horseshoe-shaped trench, 24 feet wide at the base, with 2:1 (horizontal to vertical) side walls, and varied from 10 to 25 feet in depth. The GWIS, landfill clay barrier (LCB), and landfill drain (LD) were placed in the trench. The relationship between these features is shown on Figure 2-3. The LCB is a 10-foot-thick layer of lower-permeability material placed on the outer side of the landfill trench system, designed to reduce flow between the Present Landfill and surrounding materials. The GWIS consists of a 1-foot-wide, vertically sloping sand and gravel filter blanket on the outer side of the landfill trench. Around the majority of the Present Landfill, a perforated drain pipe was placed at the base of the filter blanket. The perforated pipe drains to nonperforated pipes that discharge collected groundwater to the former West Landfill Pond, East Landfill Pond, or No Name Gulch east of the landfill pond dam. The LD consists of a 5-foot-thick layer of gravel backfill placed in the bottom of the Landfill Trench System. The LD is approximately 12 feet wide at the base of the Landfill Trench System and was open at the eastern ends of the trench to discharge to the West Landfill Pond. The remaining space in the trench was filled during landfill operations. The trench has been completely covered during landfill operations.

North/South Slurry Walls

Two soil-bentonite slurry walls were constructed in 1982 to prevent groundwater migration into the expanded landfill area. These slurry walls are located to the north and south of the eastern portion of the Present Landfill. The slurry walls are believed to be tied into the LCB.. The nonperforated section of the GWIS pipe crosses the slurry walls through a section of ductile iron pipe. The slurry walls are believed to penetrate the weathered bedrock zone.

Waste characteristics

The landfill received numerous solid waste streams from operations at RFETS. The waste was delivered to the landfill during the day, spread and compacted, and then covered daily with soil. At the time of the Phase I investigation, soil cover material used in the landfill was obtained from Rocky Flats alluvium at a location outside the Present Landfill.

Base of Landfill

The landfill was started at the western end of No Name Gulch. The base of the gulch was covered with onsite soil from a borrow area to a depth of 5 feet and approximately 20 feet in length across the channel to begin landfilling operations in 1968 (Rockwell 1988). The landfill appears to sit on native soil of varying thickness in most places and on weathered bedrock elsewhere.

West Landfill Pond

The LD drained to the West Landfill Pond. This was a temporary impoundment, approximately 0.5 acre in size. This area was covered by landfill expansion in May 1981. According to the 1988 Landfill Closure Plan (Rockwell 1988), the west embankment and pond were removed during landfill expansion.

Seep.

Water from the landfill historically discharges as a seep at the base of the eastern face of the landfill. This location is known as surface water sampling location SW097.

East Landfill Pond Dam

An engineered dam structure with a spillway is present in No Name Gulch east of the landfill. This structure was constructed in 1974, with a low-permeability clay core keyed into bedrock.

Current East Landfill Pond

A pond stores accumulated water to the east of the landfill. The pond is approximately 2.5 acres in size and is managed to maintain approximately 75 percent of capacity (5.5 million gallons). The water was historically disposed of by spray evaporation to the north and south of the pond area. Since 1995, excess pond water has been handled by pumping to the A-Series ponds in the RFETS system. Any references to the landfill pond in this report refer to the East Landfill Pond unless specifically noted otherwise.

Natural System

The natural system consists of unconsolidated, surficial, material overlying weathered bedrock. The surficial material is vegetated, with precipitation and ET being the dominant water balance components (K-H 2002a).

Surface Routing

A surface water diversion ditch is located just outside the landfill fence and follows the fence perimeter on the northern and southern sides of the landfill. The ditch eventually discharges to drainages of No Name Gulch below the East Landfill Pond.

McKay Ditch

McKay ditch lies northwest of the Present Landfill. It is used intermittently by the City of Broomfield to transport water to the Great Western Reservoir east of RFETS.

Figure 2-2. Present Landfill Features

(ATTACHED)

Figure 2-3. Generalized Landfill Trench System (Rockwell, 1988)

(ATTACHED)

2.2.2 Brief Site History

The history of the Present Landfill area has been described in detail in various documents (Rockwell 1988; DOE 1994; DOE 1996). From these reports, significant landfill modifications that likely impacted the system hydrology are as follows:

- 1968 – Landfill operations began.
- 1974 – Interim response action involved construction of the Landfill Trench System, landfill ponds, and surface water diversion ditch.
- 1978 to 1981- Eastward expansion of the landfill covered the West Landfill Pond area.
- 1982 - North and South slurry walls were constructed along the eastern expansion of the landfill.
- 1985 to 1990 – Asbestos was disposed in pits east of the landfill.
- 1993 – The landfill surface was regraded and reseeded.
- 1996 – The initial treatment system was installed for the SW097 seep.
- 1998 – The landfill waste disposal ceased and landfill was placed in "contingent closure status."
- 1998 – The landfill cover was reseeded.

The 1974 interim response action resulted in the largest subsurface modification of the landfill hydrology. The action was undertaken in 1974 to control the generation and migration of landfill leachate. This action included construction of a surface water diversion ditch around the perimeter of the landfill, two detention ponds immediately east of the landfill, and a horseshoe-shaped trench around the current perimeter of the landfill. The trench included a subsurface GWIS for diverting groundwater around the landfill, a LCB between the waste and the natural system, and a subsurface LD.

The other major subsurface modification at the landfill was the installation of the north and south slurry walls in 1982. These soil-bentonite slurry walls were constructed to prevent migration of groundwater into the expanded landfill area as the landfill expanded eastward.

3.0 AVAILABLE SITE DATA/DATA INTERPRETATION

This section provides a brief description of the available data on the Present Landfill area. An interpretation of the data, as it related to constructing the site conceptual model and numeric flow model, is included.

Climate, topography, geology, hydrogeology, vegetation, and hydrology are described in Sections 3.1 through 3.5.

3.1 Climate

The RFETS climate is temperate and semiarid, characteristic of Colorado's Front Range. The dry atmosphere of the Site at 1,830 meters (m) elevation above mean sea level (MSL) often causes wide temperature fluctuations between daytime and nighttime. Summer high temperatures are typically in the upper-20 degrees Centigrade (°C), with nighttime lows falling to approximately 16°C (EG&G 1993). During the winter, temperatures typically range from 4°C to 7°C during the day and -9°C to -4°C at night. Arctic and Siberian air masses occasionally bring frigid air during the winter when low temperatures may drop to between -21°C and -24°C (EG&G 1993).

The average annual precipitation, based on 30 years of record, is approximately 368 millimeters (mm) (DOE 1995). Data obtained from the Site meteorological station for the SWWB showed an annual precipitation range of 262 to 549 mm. Roughly half of the precipitation occurs as rain and half as snow, with precipitation falling primarily as snow from late October through early April, and as rain during the remaining months (RMRS 1997). Annual snowfall averages approximately 1,778 mm, with the highest monthly snowfall average (approximately 406 mm) occurring in March (EG&G 1993). Rainfall is highest from April through June, with nearly 42 percent of the average annual precipitation occurring during those months (EG&G 1993).

3.1.1 Evapotranspiration and Meteorological Data

Precipitation, temperature, and wind speed from the Site meteorological station for the calendar years 1993 and 1994 were obtained from the Site records. These data were obtained because the landfill wells were removed in 1995. In order to calibrate the model to actual landfill groundwater level data, it was necessary to obtain climate data for the period for which groundwater records exist. These data were recorded at 15-minute intervals at a height of 10 m. The data were reviewed for gaps. Minor data gaps were filled by interpolating between adjacent recorded data. The major data gap was for temperature (approximately 80 percent of the 1993 record). This temperature gap for 1993 was replaced with daily minimum and maximum temperatures from the Boulder, Colorado, National Climatic Data Center (NCDC) weather station. A daily temperature cycle was synthesized from the minimum and maximum temperatures for the missing 15-minute data.

Potential evapotranspiration (PET) was calculated using daily minimum and maximum temperature, average wind speed, and precipitation. The REF-ET Program (Allen 2000) was used to calculate the PET for a grass reference crop. The PET calculation used the Food and Agricultural Organization (FAO56) version of the standard Penman-Monteith equation. This program uses different assumptions for calculating PET, depending on the limitation of the input. For the 1993 and 1994 climate data, the output was a daily PET amount that was distributed at two-hour intervals for model input. The PET calculated for the SWWB (K-H 2002a) was used for the 1995 modeling period. The PET for the Water Year (WY) 2000 was recalculated using the SWWB meteorological data using the same methodology as used for the 1993 and 1994 data.

3.1.2 Temperature Data

Temperature data were used to calculate snowmelt. The numerical model uses a simple degree-day method to determine the rate of snowmelt. Fifteen-minute data were available for the 1994 period and from the SWWB for the 1995, WY2000, and WY2001 periods. For the part of the 1993 period with only minimum and maximum temperatures, a daily temperature cycle was constructed for the missing 15-minutes of data.

3.2 Topography

Landfilling operations changed the topography of the Present Landfill area continuously until operations ceased in 1998. The 1994 topography from the Site Geographic Information System (GIS) was used for the initial modeling period. This fixed topography reflected the topography during the modeling period. It was assumed the topography changes through the modeling period were relatively minor compared to the scale of the landfill model. A revised topography from 1999 (Earth Tech 2002) was used to simulate the present conditions. The changing topography during the initial model simulation period was accounted for when necessary in evaluating the groundwater depths.

3.3 Geology and Hydrogeology

RFETS is situated approximately 2 miles east of the Front Range of Colorado, on the western margin of the Colorado Piedmont section of the Great Plains Physiographic Province (Spencer 1961). The surface cover is composed of a series of coalescing alluvial fans developed during the Pleistocene. The Present Landfill is located near the eastern extent of the alluvial-fan deposits. Dissection of the gravel-capped pediment has occurred by headward erosion and planation along eastward-flowing streams and their tributaries. The Present Landfill is located in No Name Gulch at the western limit of headward erosion and pediment dissection. Waste material has been placed on top of the modified gulch surface and fills the gulch to the top of the pediment at approximately 6,000 feet. Some waste material is mounded above the top of the pediment, especially near the center of the landfill.

Geologic units at RFETS can be grouped into two general categories: unconsolidated surficial deposits and underlying consolidated bedrock (RMRS 1999). Brief descriptions of major geologic units and hydrogeology at the Present Landfill are provided below. Additional detail is provided in the *Technical Memorandum - Final Work Plan Operable Unit 7* (DOE 1994), Hydrogeologic Characterization Report for the Rocky Flats Environmental Technology Site (EG&G 1995a), and Appendix A of the Geologic Characterization Report for the Rocky Flats Environmental Technology Site (EG&G 1995b).

A range of saturated hydraulic conductivity values have been determined for materials at the Present Landfill and elsewhere at RFETS. The saturated hydraulic conductivity values from the OU#7 Phase I investigation (DOE 1994) and the SWWB (K-H 2002a) are summarized in Table 3-1.

Table 3-1. Saturated Hydraulic Conductivity Values

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3.3.1 Unconsolidated Surficial Deposits

At the Present Landfill, surficial deposits include Rocky Flats alluvium, Quaternary colluvium, artificial fill, and valley-fill alluvium (Figure 3-1). The Rocky Flats alluvium caps the divides north and south of No Name Gulch. The Rocky Flats Alluvium is 5 to 10 m thick on the northwestern, western, and southwestern sides of the landfill and 3 to 5 m thick on the divides north and south of the East Landfill Pond. Colluvium covers the valley slopes between the piedmont on which the Rocky Flats Alluvium is deposited and the No Name Gulch drainage or the East Landfill Pond. The colluvium is 0.3 to 1.5 m thick on the slopes around the East Landfill Pond and below the dam. Valley-fill alluvium deposits in the No Name Gulch drainage downstream of the East Landfill Pond are 1 to 3 m thick in the landfill area and become thicker downstream to the east (Figure 3-2).

The unconsolidated surficial deposits are the most permeable natural materials at the Present Landfill area. The geometric mean hydraulic conductivities include 2.5×10^{-3} centimeters per second (cm/sec) for valley-fill alluvium, 1.6×10^{-4} cm/sec for the Rocky Flats Alluvium, and 9×10^{-5} cm/sec for the colluvium (Table 3-1).

Figure 3-1. Surficial Geology Distribution

(ATTACHED)

Figure 3-2. Unconsolidated Material Thickness with Model Grid

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3.3.2 Consolidated Bedrock Deposits

Bedrock from the Arapahoe, Laramie, Fox Hills, and uppermost Cretaceous Pierre Formations are present at RFETS (EG&G 1995b). At the Present Landfill, bedrock unconformably underlies the surficial deposits. Only the weathered portions of the Arapahoe Formation transmit significant groundwater flows (K-H 2002a). However, both the weathered and unweathered bedrock are included in the Present Landfill model.

The weathered and unweathered bedrock surfaces were interpreted for this model using logged geologic contacts from numerous sources, including:

- The Site-wide 14-well master list;
- The 1974 Landfill Renovation Report (Zeff, Cogorno, and Sealy 1974);
- The 1977 Landfill Expansion Report (Lord 1977);
- The 1982 slurry wall installation drawings (included in DOE 1994); and
- The Conepenetrometer testing (CPT) data from the Phase I Remedial Investigation (RI) (DOE 1994).

This data compilation and interpreted surfaces are more complete than any previously reported for the Present Landfill area. Depths to the weathered bedrock were reviewed and corrected for ground surface changes in the landfill area. A depth to the top of the weathered bedrock surface was then constructed using Arcview Spatial Analyst. The weathered bedrock surface elevation was determined by subtracting the depth to weathered bedrock from the ground surface elevation. The interpreted weathered bedrock surface and control points are shown on Figure 3-3.

A similar procedure was used to create an unweathered bedrock surface. The interpreted unweathered bedrock surface and control points are shown on Figure 3-4.

Figure 3-3. Surface of Weathered Bedrock on Model Grid

(ATTACHED)

Figure 3-4. Surface of Unweathered Bedrock on Model Grid

(ATTACHED)

The Arapahoe Formation is generally less than 8 m (25 feet) thick at the Site, occurring as claystone and silty claystone with lenticular sandstone in the basal portion of the formation (EG&G1995b). Mean weathered bedrock conductivities were 2.8×10^{-5} cm/sec for siltstone and 8.8×10^{-7} cm/sec for claystones for the SWWB. The OU#7 Phase I investigation reported a geometric mean for undifferentiated weathered bedrock of 4.4×10^{-7} cm/sec (Table 3-1).

Below the Arapahoe Formation, the unweathered Laramie Formation is approximately 180 to 250 m (600 to 800 feet) thick. It is composed of an upper, thick claystone interval and a lower sandstone/claystone/coal interval. The claystones with low hydraulic conductivities inhibit downward groundwater flow. Shallow groundwater is instead directed laterally along the surface of the unweathered bedrock surface. Beneath the unweathered Laramie Formation is the regional Laramie-Fox Hills aquifer. A U.S. Geological Survey study and a separate, peer-reviewed Site investigation both indicate this aquifer will not be impacted by RFETS activities because of the low permeability of the overlying Laramie Formation (RMRS 1996). The Laramie-Fox Hills aquifer is approximately 200 to 300 m (650 to 1,000 feet) below the Site. Below the Laramie-Fox Hills aquifer is the 2,300 m (7,500-foot) thick Pierre Formation that acts as the aquifer's lower confining layer. The thick marine shale of the Pierre Formation subcrops only in the extreme western part of the Site (RMRS 1999).

Subcropping, fine-grained Arapahoe sandstones were only identified at one well downgradient of the East Landfill Pond (DOE 1994). Due to the limited extent, continuity, and definition of the Arapahoe sandstones in the Present Landfill area, the Arapahoe sandstone was not explicitly included in the modeling.

3.3.3 Waste and Artificial Fill

The central feature of the Present Landfill is the artificial fill, mainly landfilled waste material present in the approximately 20 acres of the Present Landfill area.

Landfill operations began in 1968 with the western end of the drainage channel being filled with onsite soil from a borrow area, to a depth of 5 feet and approximately 20 feet in length across the channel (Rockwell 1988). Waste material delivered to the site was spread across the current work area, compacted, and covered with soil. At the time of the Phase I investigation (DOE 1994), soil cover material stockpiled and used at the landfill was Rocky Flats Alluvium. The total volume of landfilled material was estimated at approximately 415,000 cubic yards, with approximately 30 percent of that volume being the daily soil cover (DOE 1994).

A map showing the interpreted base of the landfill was generated (DOE 1994) using borings and CPT data from the Phase I investigation (Figure 3-5). This map was scanned and digitized and then combined with the elevations of the base of the landfill trench to establish a model base of the landfill. The thickness of the waste and interim cover material ranges from approximately 1 to 15 m, with the fill thickest near the centerline of the valley and thinnest around the perimeter of the landfill. The interpreted waste thickness is shown on Figure 3-6.

Other artificial fill material in the Present Landfill area are materials used to construct the GWIS, LCB, LD, and Landfill Pond Dam. The GWIS, LCB, and LD were all covered during landfill operations. Asbestos was disposed of in pits east of the main landfill. This area is included in the total landfill area. Additional artificial fill in the study area includes the shooting range and excavated materials from McKay Ditch.

Reported geometric mean hydraulic conductivities from the OU#7 Phase I investigation for the waste material and underlying unconsolidated material were 3.7×10^{-5} cm/sec. Literature values for municipal solid waste range from 1.5×10^{-4} to 2.0×10^{-2} cm/sec (Table 3-1) (Qian et al. 2002).

Figure 3-5. Base of Landfill (from DOE 1994)

(ATTACHED)

Figure 3-6. Interpreted Waste Thickness

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3.3.4 Structure

A possible fault was inferred in the Present Landfill area during the Site-wide Geoscience Characterization Study (EG&G 1995a). The inferred fault trends northeast-southwest and lies east of the landfill face near the edge of the East Landfill Pond. The fault plane dips to the west. The surficial deposits were not offset, suggesting that movement had not occurred since their deposition (EG&G 1995a). This structure is not likely significant to groundwater flow near the Present Landfill based on groundwater levels and the lack of offsetting in the more permeable surficial deposits.

3.4 Vegetation

The Site's topography and close proximity to the mountains support a unique, diverse array of prairie and foothills plant communities that have been extensively characterized in multiple studies (K-H 1997a; 1997b; 1997c) and mapped in detail. Vegetation is an important component of the Present Landfill study because of the impact that ET has on net infiltration reaching the water table and hence the water balance. Specific plant communities present in or near the Present Landfill include mesic and xeric mixed grassland, disturbed areas (developed or barren land), short marsh, wet meadow, and wetlands. The most significant plant communities in the study area include:

- The xeric tallgrass prairie;
- The mesic mixed grasslands east of the landfill pond dam, upon which the reseeding of the landfill is based;
- Annual grass/forb community around the landfill;
- Disturbed areas or barren land due to the continuous earthmoving at the landfill. Plants have little opportunity to germinate, grow or establish in these areas;
- The Great Plains riparian community, mapped as riparian (stream channel) woodland and shrubland, found along streams. Cottonwood trees and willows predominate in this plant community; and
- Wetlands present around the East Landfill Pond, No Name Gulch, and McKay Bypass Canal. This is a combination of areas described as wet meadow, short marsh, and tall marsh.

The distribution of the various vegetation types used for the calibration model is shown on Figure 3-7. Following placement of the landfill in interim closure status in 1998, the landfill area was reseeded. The selected seeding mix is most similar to the natural mesic mixed grassland, with very good health and vigor (K-H 2002b).

Figure 3-7. Vegetation Distribution

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3.5 Hydrology

Subsurface and surface water hydrology are described in this section.

3.5.1 Subsurface Hydrology

The saturated flow system is understood using groundwater well information. There are two principal ways in which the data can be evaluated to assess the groundwater flow response. The first is by interpolating groundwater well data to establish groundwater flow directions. The second is by evaluating the temporal response of the groundwater well data. Groundwater well locations used in this study to evaluate the flow conditions are included on Figure 3-8. Different colored symbols depict the screened formation. For example, "alluvium" means the well is screened entirely within the alluvium, "bedrock" means entirely in the bedrock, and "alluvium/bedrock" indicates the well is screened cross-formation. Yellow triangles in some of the wells indicate these are wells in which data are available from 1993 through mid-1995 (calibration period). All wells within the waste were abandoned shortly after 1995. As a result, the 1993 to mid-1995 time period is particularly useful in terms of evaluating waste-specific groundwater flow characteristics.

Figure 3-8. Groundwater Well Locations

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Potentiometric Groundwater Surface

Developing a potentiometric surface within the landfill area requires that an adequate spatial distribution of well data points is available. Temporal analysis indicates that water levels vary significantly over the year, but measurements are not synchronized in time. As a result, accurate definition of potentiometric surfaces at a given point in time are not possible with the available data. Average annual water levels were calculated at each well point and used to interpolate an approximate potentiometric surface. Results are used for initializing the flow model and generally show that the water levels closely mimic regional surface topography and the weathered bedrock surface.

Temporal Groundwater Response

The temporal response of groundwater depths with time were evaluated. Seven well sets, each consisting of at least four wells are identified on Figure 3-9. The well sets were installed to monitor effects of the north and south slurry walls (two well sets), while the five sets to the west monitored effects of the trench system and are located across this feature.

Figure 3-9. Trench System Groundwater Well Locations

(ATTACHED)

The temporal response of water depths in groundwater wells installed with waste is summarized on Figure 3-10. Two key observations can be made from these data. First, groundwater depths are generally greater than external, "natural" system wells. The second is that the well response generally shows much less variability than external wells. This reflects a "dissipated" recharge response (April period), characteristic in deeper groundwater wells (i.e., due to deeper unsaturated zone). It also suggests that the recharge/ET response characteristic of external "natural-system" wells may be damped due to the waste area landfilling techniques (i.e., alternating lifts of waste and then fill material). Some wells, such as B106089, exhibit notable sampling "lag" effects, while other wells, such as 72093 and 72393, show several discontinuities where depths increase notably over a short time period. This is due to topography changing over time and well casing adjustments (additions). Finally, well 6487 is likely almost entirely isolated from surface response as its water level continuously and smoothly declines with time. All waste wells, except 6487, appear to exhibit some recharge response to the large spring precipitation events in 1995, indicating they are not entirely isolated from surface recharge.

Figure 3-10. Waste Groundwater Well Response

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Groundwater well response near the north (wells 393, 6787, and 6887) and south (wells B206389, 493, 7287, and B206489) slurry walls is summarized on Figure 3-11. Both sets of wells exhibit notable seasonal variability, with depths ranging from 2 to 5 feet. Again, water levels rise shortly after spring precipitation events, generally around April. The recharge response is likely due to low PET rates and a series of precipitation events. This may be enhanced by snowfall with high water contents. The high seasonality evident in groundwater levels masks any lateral flow adjustments caused by the slurry walls, although interior wells (waste-side) exhibit slightly lower depths than exterior wells, which is an expected response to the slurry walls.

Figure 3-11. Slurry Wall Groundwater Well Response

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Groundwater well responses along the northeastern and northwestern GWIS are illustrated on Figure 3-12. As with other nonwaste wells, groundwater level variability exhibits notable annual recharge response. In both well sets, the waste wells (6387, 6287, 71493, and 71193) exhibit annual recharge variability, although it is not as pronounced as neighboring external wells. These data do not suggest that there is any hydraulic connection between external wells and waste wells, only that their response is sensitive to direct recharge. This is further supported by rapid recharge responses, rather than lagged response, which suggests the influence of lateral inflows.

Figure 3-12. GWIS Groundwater Well Response (North)

(ATTACHED)

Well responses located at the western end of the trench are summarized on Figure 3-13. Bedrock wells in this area (70593 and 986) show clear signs of sampling-recovery effects (i.e., groundwater depths increase sharply but slowly decrease to ground surface). Waste well B106089 shows relatively deep levels with only limited annual recharge response to the 1995 event. All other external alluvial well depths are shallower and show consistent annual groundwater recharge responses, similar to other external well set responses.

Figure 3-13. GWIS Groundwater Well Response (West)

(ATTACHED)

Southwestern well set water depth responses are summarized on Figure 3-14. The external bedrock well 70893 exhibits typical sampling-recovery effects due to the low hydraulic conductivity of the weathered bedrock at this location. Waste well 71693's annual recharge response is similar in magnitude to that of external alluvial wells 71893 and 70693, but exhibited a slight lag to maximum water level in 1994 probably due to the greater groundwater depth of 71693. The lower plot shows groundwater elevations, which suggest an inward flow directed toward the landfill.

Figure 3-14. GWIS Groundwater Well Response (Southwest)

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Groundwater depths for the southeastern GWIS well set are summarized on Figure 3-15. The shallower waste well in this set, 6487, exhibits a lack of sensitivity to recharge and is slowly draining over a three-year period. Adjacent bedrock well B206189 appears to register a similar recharge response as the alluvial wells; however, its depth is greater (approximately 20 feet) and its variability is greater. Over one year, it is not possible to assess whether this is accurate, although external bedrock well B206289 shows a similar depth and response magnitude. The waste wells appear to be isolated from the consistent annual recharge response exhibited in external wells 6687, 597, and 6587. It is interesting to note that none of the wells closest to the trench centerline exhibit any damping effects caused by possible drain effects in this area.

Figure 3-15. GWIS Groundwater Well Response (Southeast)

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Landfill Trench System

The Landfill Trench System was placed around the northern, western, and southern sides of the Present Landfill in 1974. It was a horseshoe-shaped trench, 24-feet wide at the base with 2:1 side walls, and varied from 10 to 25 feet in depth. The GWIS, LCB, and LD were placed in the trench. The remaining space in the trench was filled during landfill operations. A side view of the landfill trench and the spatial relationship of the varying components is shown on Figure 2-3.

The Landfill Trench System and its components provide a hydraulic barrier to groundwater flow in to and out of the landfill. The GWIS and LD will tend to depress groundwater levels due to the higher hydraulic conductivity of the features if they are functioning properly.

As-built drawings show the highest trench invert elevation near well 5987 at the western end of the trench. The trench inverts slope to the east with a 1 percent grade. A portion of the southern side of the trench has a 2 percent slope. The eastern portions of the trench, where the trench discharged to the former West Landfill Pond had steeper slopes of up to 10 percent grade.

Landfill Drain

The LD consists of a 5-foot-thick layer of gravel backfill placed in the bottom of the Landfill Trench System. The LD is approximately 12 feet wide at the base of the trench system and was open at the eastern ends of the trench to discharge to the West Landfill Pond. The LD tends to depress groundwater levels and route flow along its path by providing a preferential flow path.

Clay barrier

The LCB is a vertically sloping (2:1) barrier of lower-permeability material placed on the outer side of the Landfill Trench System. It was designed to reduce flow between the Present Landfill and surrounding materials. The as-built drawing of the typical landfill trench section and the interpretation of the landfill trench shown in the 1988 closure document (Rockwell 1988) indicate the barrier was built of clayey silt or sandy clay and had an approximate horizontal width of 10 feet. The LCB channel flow to the GWIS and LD. It provides a physical barrier to horizontal flow even if the GWIS or LD is not functioning.

GWIS Drain (Perforated and Nonperforated)

The GWIS consists of a 1-foot-wide, vertically sloping sand and gravel filter blanket on the outer side of the Landfill Trench System. This higher-permeability filter blanket provides a preferential flow path along the LCB, toward the perforated GWIS drain pipe. Around the majority of the Present Landfill, a perforated drain pipe was placed at the base of the filter blanket. The perforated pipes then attached to nonperforated pipes that may discharge the collected groundwater to the West Landfill Pond, East Landfill Pond, or No Name Gulch east of the landfill pond dam. The GWIS appears to be intersected by both the north and south slurry walls. At the intersection the existing drain pipe was replaced by a ductile iron pipe that was encased in concrete. The only hydraulic connection of the GWIS across the landfill slurry walls is through this ductile iron pipe connection.

The GWIS discharge points to No Name Gulch east of the landfill pond dam are surface water sampling stations SW099 and SW100. During the Phase I field investigation, intercepted groundwater was presumably discharged into the East Landfill Pond rather than No Name Gulch (DOE 1994). A review of the Soil Water Database (SWD) data available on these discharge points showed only two blank entries for flow rate from

SW099 and no flow rate entries for SW100. The discharge points into the East Landfill Pond are not visible from the surface (DOE 1996).

Flow rates for the GWIS are not currently quantified. Any current discharge goes to the East Landfill Pond either by direct discharge or by flow from the landfill mass if the GWIS discharges to the former West Landfill Pond.

Waste Characteristics

The distribution of landfill waste material is described in Section 3.3.3. The landfill waste material includes a mixture of clay, sand, and gravel containing asphalt, concrete, insulated wire, wood, paper, plastic, rubber, metal, construction ribbons, surgical gloves, saranex suits, and other materials associated with landfilling activities (DOE 1994). Additionally, there are two pits approximately 10 feet deep on the eastern portion of the landfill that contain asbestos-containing material which was placed in heavy plastic bags and covered with soil when the pit became full.

Geologic units beneath the landfill waste consist of a thin covering of colluvium on the hillsides and valley-fill alluvium in the No Name Gulch drainage (DOE 1996). The underlying material has also been described as clay, sand, and gravel fill material beneath the waste (DOE 1994).

Landfill Seeps

There is a seep at the base of the eastern face of the landfill (SW097) that discharges into a treatment system. Flow from the seep has been estimated varying ways, with the best data available since the installation of the passive aeration treatment system. Reported flow rates in the seep vary. The range of reported values was 0 to 6.7 gallons per minute (gpm). Values of 24.7 and 26.9 gpm are believed to be erroneous. The average historical flow rate for measurements from 1988 to 1990, after discarding two measurements believed to be erroneous, was 2.5 gpm (DOE 1994). The reported seep flow rate during the Phase I investigation was 0.01 to 0.02 cubic feet per second (cfs) (4.5 to 9.0 gpm) (DOE 1994). Based on seep flow measurements taken between 1998 and 2001, the four-year average flow was 2.6 gpm, the average flow during the wettest year (1998) was 3.2, gpm and the average flow rate during the wettest month of the period (June 1999) was 3.7 gpm. Although 1995 was the wettest year in recent history, there are no flow records available for this year (Earth Tech, 2002).

An intermittent seep has been observed north of SW097 on the hillside just below the north asbestos-disposal area. This intermittent seep is most likely caused by saturated materials related to storm events. Heavy surface water runoff has been observed in this area following storm events. Recent slumps have also been observed in this area (DOE 1996a).

Former West Landfill Pond

The LD discharged to the West Landfill Pond. This was a temporary impoundment, approximately 0.5 acre in size. This area was covered by landfill expansion in May 1981. According to the 1988 Landfill Closure Plan (Rockwell 1988), the west embankment and pond were removed during landfill expansion. The former pond area received the LD discharge, and the topography concentrated flow in this area.

East Landfill Pond Dam

An engineered dam structure with a spillway is present in No Name Gulch east of the landfill. This structure was constructed in 1974, with a low-permeability clay core keyed into bedrock. The dam design drawings and geologic interpretation (DOE 1994) indicate that the dam core was keyed in the upper portion of the weathered bedrock at the dam location. It does not appear from these sources that the dam core was keyed all the way through the weathered bedrock.

North/South Slurry Walls

Two soil-bentonite slurry walls were constructed in 1982 to prevent groundwater migration into the expanded landfill area. These slurry walls are located to the north and south of the eastern portion of the Present Landfill. The slurry walls are believed to be tied into the LCB. The GWIS pipe crosses the slurry walls in a section of ductile iron pipe. The slurry walls are believed to enter the weathered bedrock.

3.5.2 Surface Hydrology

This section describes the surface hydrology features near the Present Landfill, namely the East Landfill Pond, McKay Ditch, and surface routing.

East Landfill Pond

The East Landfill Pond was formed by the landfill pond dam. The pond has a spillway elevation of 5,921 feet above MSL and a 100 percent capacity of 7.5 million gallons. The landfill pond level is controlled to maintain the pond volume at approximately 75 percent capacity (5.5 million gallons). Historically, the water volume was controlled by spray evaporation, which ceased in 1994. Since spray evaporation ended, pond volumes are controlled by pumping the pond water to the A-Series ponds onsite. Pumping transfers have typically occurred up to three times per year and involved up to 7.5 million gallons per year. The pond receives overland runoff from parts of the landfill and the surrounding terrain.

Reported pond levels for the period 1992 to 2001 are shown on Figure 3-16. The pond levels show rapid response to precipitation events or discharge events in the range of 1 to 2 m. During other periods, the pond levels gradually rise. The pond receives flow from the SW097 seep, surface water runoff, and potentially groundwater inflow. The pond loses water from evaporation, ET of surrounding vegetation, pumping discharges, and leakage to the groundwater system.

Figure 3-16. Present Landfill Pond Levels

(ATTACHED)

McKay Ditch

The McKay Ditch is located northwest of the Present Landfill. It flows intermittently and does not appear to affect groundwater at the Present Landfill.

Surface Routing

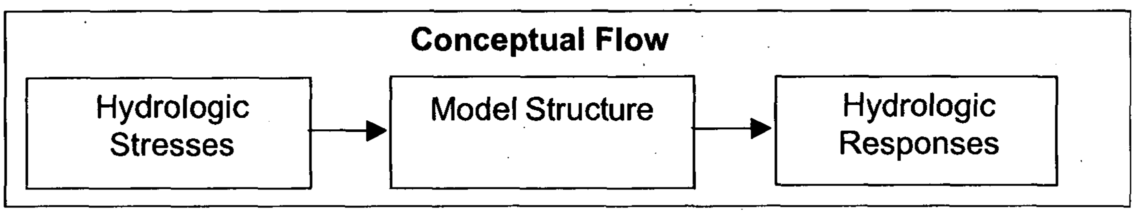
A surface water diversion ditch was constructed around the perimeter of the landfill in 1974 to divert surface water runoff around the landfill. The diversion ditch is 2 to 3 feet deep and 5 feet wide at the bottom. The ditch is trapezoidal in shape and the slopes and floor of the ditch are composed of sparsely vegetated native soil material (DOE 1996). The diversion ditch discharge ultimately goes into No Name Gulch below the Present Landfill dam. This ditch does not flow consistently and no flow data were found.

4.0 CONCEPTUAL MODEL FOR THE INTEGRATED FLOW SYSTEM

The model boundary and key features of an integrated conceptual flow model of the Present Landfill flow system are described in this section. Important features and flow processes within the study area are discussed. It is important to recognize that limitations in the current understanding of how the system operates require that basic assumptions be made. This effectively translates into uncertainty in the conceptual flow model. For example, the GWIS drain does not discharge, or discharge to locations, as designed. As such, certain assumptions are necessary to define a conceptual flow model. This model represents only one possible conceptualization of flow within the system and others may be more realistic. Nevertheless, conceptual flow models are typically evaluated during model calibration, and this information is then used to iteratively revise the conceptualization.

Basic features of the integrated conceptual model developed for the Present Landfill system are included on Figure 4-1. Different model structures are identified to define the underlying surface and subsurface hydrogeologic framework and hydraulic properties that control flow in the Present Landfill system. For example, the surface topography is the main structure controlling overland flow; channel profiles and streambed topography define the stream flow network; and hydrostratigraphy defines the subsurface flow structure.

Figure 4-1. Conceptual Flow Model Components



The model structure is acted upon by different external hydrologic stresses that in turn produce different hydrologic responses. The term hydrologic stress is used instead of more traditional terminology such as "boundary conditions" to emphasize that important internal processes are not simplified in a fully integrated model. Hydrologic stresses in the Present Landfill model include: (1) precipitation (rain or snowfall); (2) potential ET; and (3) temperature. These stresses vary temporally over the model area, but are assumed to be spatially uniform given the relatively small model area.

The combined effect of external stresses acting on the model structures produce several hydrologic responses. Responses occur as changes in flows, or system pressures within the surface or subsurface flow systems. For example, as precipitation reaches the ground surface, it begins to infiltrate. If the precipitation intensity is high enough, or soil is saturated from below, water ponds at the ground surface. Under these conditions, overland flow occurs. It can concentrate and become channelized.

Within the unsaturated zone, moisture contents adjust to surface infiltration events due to precipitation events. The unsaturated zone also responds to daily and seasonal changes in soil evaporation and plant transpiration. Eventually infiltrating moisture reaches the groundwater table as groundwater recharge. The groundwater table increases during these recharge events, but then decreases in response to direct loss through ET, or saturated zone flow adjustments within the system. When the groundwater levels change, groundwater flow directions and velocities can also change. As groundwater reaches the ground surface at locations other than streams, seeps are produced, which, in turn, can cause overland flow (return flow).

The model boundary for the conceptual and numerical model is described first in Section 4.1. The general hydrologic behavior of the flow system, described in Section 4.2, is used to describe key aspects of the conceptual model developed for the Present Landfill system. The dominant hydrologic processes and their interaction with each other are described, and important Site features or conditions controlling these processes are identified. To support this conceptualization of system behavior, a substantial amount of data were reviewed and interpreted. These data and interpretations were described in Section 3.0.

4.1 Model Boundary

The Present Landfill hydrologic model boundary was defined based on an initial evaluation of hydrologic conditions at the landfill. Simple model boundaries were defined within the study area so that realistic boundary conditions could be specified in the integrated hydrologic flow model. Horizontal and vertical flow conditions were used to define the subsurface boundaries. Only horizontal conditions were specified for the surface system. The horizontal extent of the model boundary encompasses an area of approximately 210 acres.

Vertical (upper and lower) boundaries for the integrated Present Landfill model are the topographic surface and the bottom of the unweathered bedrock formation with a fixed thickness of 600 feet in the model, respectively. The bottom boundary was chosen to enable simulation of flow in the upper portion of the unweathered bedrock near features such as the East Landfill Pond dam. The unconsolidated material and weathered bedrock are consistent with the upper hydrostratigraphic unit (UHSU) definition described in the Hydrogeologic Characterization Report (EG&G 1995a). The unweathered bedrock was included to allow for examination of potential flow near the landfill dam.

The western, northern, and southern model boundaries represent no-flow conditions for overland flow. Although overland flow can cross the eastern model boundary, it is considered negligible and effectively this is a no-flow boundary.

4.2 Conceptual Flow Model

A conceptual flow model for the Present Landfill includes components of surface water and groundwater hydrology and the interactions between surface water and groundwater.

Flow within the conceptual model is depicted graphically on Figure 4-2. Key features affecting flows in the system, as well as flow directions (sized according to relative flow magnitude) are included in the figure. Only flows within the landfill system (i.e., trench system, waste area, seep, landfill pond, and dam) are discussed here. The external flow system is not described.

Precipitation in the form of rain or snow intercepts ground surface and begins to infiltrate. If the storm intensity and duration are sufficient, ponding may occur, although under typical conditions, this generally does not occur (not even once per year). Ponding then leads to surface runoff, which is diverted around the landfill and eventually discharged to No Name Gulch below the East Landfill Pond dam.

Shallow surface infiltration rates of precipitation to the unsaturated zone are relatively high, given the high effective saturated hydraulic conductivities of surface soil. Although only a portion of the total infiltrated water actually recharges the saturated zone (or groundwater table), recharge rates are relatively high. Generally rates are several inches per year as reported in the recent SWWB modeling (K-H 2002a).

On Figure 4-2, groundwater flow directions are generally from west to east, but the Landfill Trench System that includes the GWIS, LD, and LCB locally redirects flows toward it. Groundwater flows vertically downward over the entire system, except as shown near the trench system and seep. Groundwater flows are greater in the unconsolidated material and waste than in the weathered bedrock due to higher average hydraulic conductivities. Flows in the unweathered bedrock are much lower than in the weathered bedrock due to even lower hydraulic conductivities.

The Landfill Trench System is not shown fully extending to the top of the weathered bedrock. Despite this, groundwater levels are still controlled by the barrier system. The LCB prevents flow from the landfill from entering the external GWIS drain, or external water from entering the LD. Groundwater beneath the waste in unconsolidated material and weathered bedrock flows laterally toward the seep as shown. Near the seep, groundwater inflows (toward the seep) from the north and south hillslope areas are limited due to the two slurry walls that extend west-east and are cored into the weathered bedrock. The slurry walls, therefore, act to additionally focus upgradient saturated zone flows toward the seep area. Seep flow varies throughout the year and has been estimated at 1 to 7 gpm.

Water flows through the groundwater system and primarily discharges through seeps. There is one primary seep at the Present Landfill located at the base on the eastern face of the landfill. A second intermittent seep area exists north of SW097 on the hillside below the north asbestos disposal area. This seep only activates during significant precipitation events, and its flow is not monitored.

At the seep, groundwater discharges to the surface from both the unconsolidated material and underlying weathered bedrock. All saturated zone flow upgradient of the seep is conceptualized as discharging at the surface at, or immediately downgradient of, the seep. Seep discharge then flows into the landfill pond after being treated. From the pond, groundwater flows beneath (within the weathered bedrock) and through the dam at a slow rate due to low associated permeabilities. Groundwater from the pond is largely constrained downstream of the dam to flow within the stream alluvium, or weathered bedrock. From here it mixes with lateral inflows from the northern and southern hillslope colluvium and landslide deposits and become subject to loss as ET. The SWWB modeling showed that most of this water is subject to loss locally via ET, while only a small portion is subject to discharge as surface water flow, which occurs infrequently (once every few years).

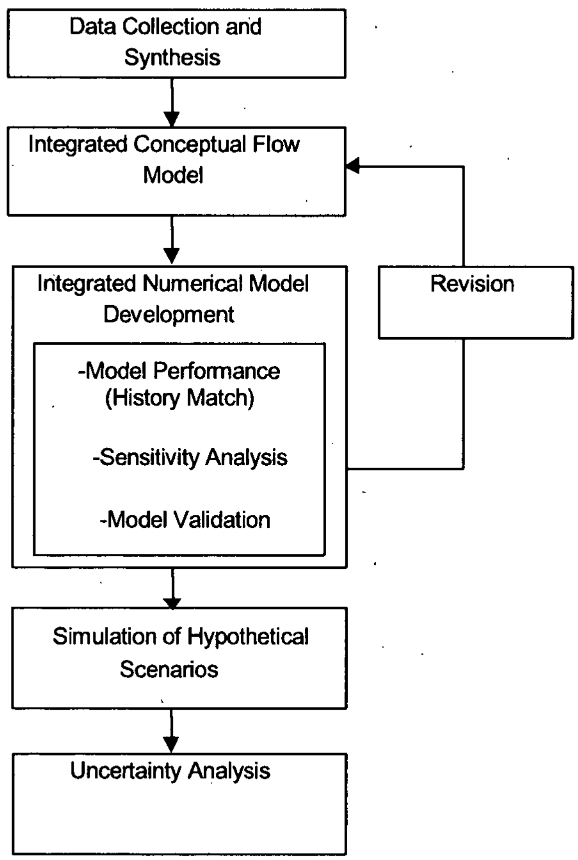
Figure 4-2. Present Landfill Conceptual Flow Model

(ATTACHED)

5.0 GENERAL MODELING APPROACH

Development of the integrated Present Landfill model follows the general approach of the SWWB (K-H 2002a). This approach considered the integrated hydrologic nature of the Present Landfill flow system, project objectives, and available code capabilities. The basic steps of this approach, outlined on Figure 5-1, generally follow the protocol suggested by Refsgaard (1996) for integrated modeling, which are largely based on the standard groundwater modeling protocol presented by Anderson and Woessner (1992). The term "model" used herein refers to an "integrated model" of the surface and subsurface saturated flow systems coupled through the unsaturated zone.

Figure 5-1. Modeling Approach



The first two steps of the approach, data collection and synthesis and developing a conceptual flow model, were summarized in Sections 3.0 and 4.0, respectively. Based on this analysis, flow within the Present Landfill is integrated and complex and has some uncertainty in operation. As a result, the MIKE SHE code used in the SWWB modeling was considered applicable for the Present Landfill modeling. It was considered the best available code to simulate such integrated behavior and represents improved methodology over previous saturated-only flow modeling using MODFLOW.

In the integrated numerical model development step, three tasks are performed. The first involves improving model performance by adjusting key model parameters considered "calibration" parameters. The concept of improving model performance is equivalent to model calibration used in traditional single-process models. However, in integrated modeling, the calibration process involves many more parameters, but is much more constrained by internal process couplings. As such, emphasis is not placed on attaining a prespecified calibration target, but rather on achieving a reasonable "history match" between observed and simulated model-predicted system response. Consistent integrated system behavior is also emphasized in this approach. For example, unsaturated hydraulic conductivity cannot be incorrectly specified to obtain reasonable recharge estimates, because the surface ponding and overland flow will be impacted negatively.

Two final tasks are performed as part of the integrated numerical model development: sensitivity analysis and model validation. The model validation is performed to assess how well the system performs under an entirely different climate sequence. The model sensitivity analysis is important in this study because it evaluates some of the uncertainty associated with the conceptual flow model (e.g., the GWIS drain is operational versus non-operational). It is also conducted to demonstrate that the "calibrated" model performs reasonably and identify key parameters that affect the system most.

A hypothetical scenario in which specified landfill cover material was adjusted is simulated using the "calibrated" model. The change in hydrologic response is evaluated from a base case defined by a model structure current as of WY2000. Finally, an uncertainty analysis should be performed, as in the SWWB modeling, to qualify such results. However, this task was not considered in this study.

As in the SWWB modeling (K-H 2002a), subscale flow models were developed in this study as proposed by Prucha (2002). Subscale single-column flow models in which unsaturated, saturated, and overland flow are simulated, along with ET and snowmelt, permit rapid solution at key wells with sufficient groundwater level response data (e.g., biweekly at many landfill area wells from 1993 to mid-1995). Other sub-regional models, such as a model of just the waste material and seep area, permit focused evaluation and parameterization of integrated model flow components in this area without the computational overhead and long simulation times. The MIKE SHE code described below provides a highly flexible and yet physically rigorous means of rapidly developing the subscale models, once the regional-scale model is developed (i.e., full landfill model).

5.1 Code Selection and Specifications

The hydrologic code, MIKE SHE (Storm and Refsgaard 1996; K-H 2002a) was used to simulate the integrated system behavior for the Present Landfill area. Key model features and processes that required use of such a code include the following:

- Overland flow from the landfill seep and from hillslopes to stream areas;
- Groundwater discharge from the groundwater interception drain;
- Flow effects caused by the GWIS clay barrier;
- Flow effects caused by the north and south slurry walls;
- Flow effects caused by the landfill pond dam;
- Infiltration and drainage through the unsaturated zone within the waste and within the surrounding natural materials;
- Exchange between unsaturated and saturated zones (recharge);
- Transient changes in three-dimensional saturated zone flow, storage, and potential heads; and
- ET losses.

MIKE SHE is an integrated, distributed, physically based, finite difference model. The code comprises a number of flow modules, which may be combined to describe flow within the entire land-based part of the hydrologic cycle including developed urban areas.

For the Present Landfill study, the computer modules listed in Table 5-1 have been applied.

Table 5-1. MIKE SHE Modules Applied for the Present Landfill Model

MIKE SHE Module	Simulates	Fully Dynamic Coupling With	Dim.	Governing Equations
MIKE SHE OL	Overland sheet flow and water depth, depression storage	MIKE SHE SZ and UZ	2-D	Saint-Venants equation (diffusive wave approximation)
MIKE SHE UZ	Flow and water content of the unsaturated zone, infiltration, and groundwater recharge	MIKE SHE SZ, OL	1-D	Richards' equation / gravitational flow (no effects of capillary potential)
MIKE SHE ET	Soil and free water surface evaporation, plant transpiration	MIKE SHE UZ, OL	-	Kristensen&Jensen / Penman-Monteith
MIKE SHE SZ	Saturated zone (groundwater) flows and water levels	MIKE SHE UZ and OL	3-D	Boussinesqs equation

The model area was discretized into a number of computational cells for the numerical solution of the governing equations. The spatial scale of MIKE SHE may be chosen either to address regional basin issues or, for the Present Landfill model, to provide a detailed local hydrologic analysis. For a more elaborate description of MIKE SHE, see Appendix D of the SWWB (K-H 2002a).

5.2 System Focus Areas

To efficiently use and communicate the large quantity of information generated by the numerical model, focus areas were identified within the model boundary. The focus areas were chosen based on Present Landfill interests and concerns for closure.

Five focus areas were identified for the study. These areas are presented on Figure 5-2 and include:

- Entire landfill and surrounding area (Catchment Model);
- Landfill waste area;
- Landfill seep (SW097);
- Landfill pond; and
- Downstream of dam.

Figure 5-2. Model Focus Area

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6.0 INTEGRATED NUMERIC FLOW MODEL

This section describes the structure and parameterization of the fully integrated numerical MIKE SHE model developed for the Present Landfill. The design of the integrated numerical MIKE SHE model is based primarily on the conceptual model described in Section 1.0. It is also based on the code structure and data requirements of MIKE SHE.

Integrated codes such as MIKE SHE are sophisticated and data-intensive. The integrated model developed here is the result of a comprehensive effort to include all important surface and subsurface features that affect the Present Landfill hydrology. Earlier modeling studies at the Present Landfill have simulated only individual components of the system hydrology (DOE 1994). As such, it is important to understand how the basic numerical model framework is structured, and how model input parameters are spatially and temporally distributed.

6.1 Spatial and Temporal Discretization

The spatial and temporal discretizations specified in the integrated flow model of the Present Landfill are presented in this section. For an integrated model, numerical grids must be specified for each process included in the model and careful consideration must be given to the combined effect of all process discretizations. Similarly, temporal time stepping must also be specified for each process and for the combined set of processes and model output. Discussions of the spatial and temporal discretizations are presented in Sections 6.1.1 and 6.1.2, respectively.

6.1.1 Spatial Discretization

The numerical grid defined for the integrated model of the Present Landfill considers important features of each hydrologic process. The model was designed to simulate localized flow conditions around the Present Landfill. Although a more accurate representation of the system could be obtained using a finer grid (larger number of calculation points), this becomes computationally inefficient.

Based on considerations of computational time versus spatial resolution, a 15.2 by 15.2-m horizontal grid was chosen to meet the project objectives. This grid was used by the overland flow, unsaturated zone, and saturated zone portions of the model. Vertical discretization, varied depending on the geologic layers.

The overland flow is a two-dimensional process. Channel flow was not included in this model because overland flow is reasonably well simulated at the grid discretization size chosen. The main surface hydrology features at the Present Landfill are the landfill seep and East Landfill Pond. The overland flow portion of MIKE SHE is able to simulate the flow of water from the seep to the pond.

The unsaturated zone flow is modeled as a one-dimensional process. The unsaturated zone columns have variable discretization, described in more detail in Section 6.2.5.

The saturated zone flow process is three-dimensional. The vertical layering of the saturated zone model is based on the geologic layering at the site. This was modified to account for certain features specific near the landfill, as described in Section 6.2.4. The model geologic layers were assigned a minimum thickness of 0.49 m for numerical stability. The model layers were created using a spreadsheet containing the geologic elevations and other features contained in each model grid cell. The geologic contacts in the spreadsheet were then manipulated to create the numerical model layers.

6.1.2 Temporal Discretization

Time step specification is important in the MIKE SHE model because it affects the solution accuracy and strongly influences the computational efficiency of the model. If time steps are too large, instabilities in the model solution occur and important dynamics may not be captured. If specified time steps are too low, simulations become computationally inefficient.

In addition to defining spatial grids for the model, the numerical solution of the flow equations also requires appropriate time steps for each process. The numerical time stepping is largely dictated by the different temporal responses for each of the hydrologic processes. For example, the saturated zone responds much more slowly to external stresses, such as precipitation, than do surface flows. As a result, the saturated zone time step is specified larger than the other processes to improve the integrated model efficiency. Time stepping for the surface water flow is not only controlled by the MIKE11 portion of the MIKE SHE code, but also by the unsaturated zone (UZ), overland flow (OF), and saturated zone (SZ) time steps.

All time steps are specified as multiples of each other to improve computational efficiency in the MIKE SHE code. The time stepping is also controlled by the amount of precipitation that occurs during a time step (i.e., intensity) and the frequency of model output. Time steps are adjusted in the code prior to reaching either of these points in time.

In the Present Landfill model, the maximum time steps are specified as follows:

- OF and UZ flow = 0.5 hour.
- SZ flow = 6 hour.

6.2 Model Components

Several model components required for developing the integrated hydrologic model of the Present Landfill are discussed in this section. Conversion of the available vegetation distribution into model zonations is described first.

6.2.1 Vegetation

Although 12 detailed vegetation categories were identified graphically in the Present Landfill area (Figure 3-7), only four broad vegetation zones were included in the model based on the SWWB (K-H 2002a). Additionally, "vegetation" zones were included for largely barren areas and open water. The 4 main zones were modified to the following 10 zones:

- Wetland;
- Mesic;
- Xeric;
- Riparian woodland;
- Landfill (where a different type of vegetation was not present);
- Disturbed/developed;
- Mudflats;
- Open water;
- Riprap; and
- Not vegetated (paved).

The spatial distribution of these ten zones in the calibration model is shown graphically on Figure 6-1. The landfill was regraded and reseeded in 1998 after landfill operations ceased, with the seed mixture closely resembling the native mesic vegetation (K-H 2002b). For the validation model simulation, vegetation in the landfill area was specified as mesic, where the leaf area index (LAI) was reduced to simulate the effects of the recent seeding.

Figure 6-1. Model Vegetation Distribution

(Attached)

The ET component (DHI 2000; Kristensen and Jensen 1975) simulates the actual ET rates as a function of vegetation-specific parameters, empirical constants, and input PET rates. The vegetation is characterized by the time-varying LAI, the root mass distribution with depth (RDF), and a crop coefficient (K_c).

The empirical parameters include an interception storage coefficient (C_{int}), a constant relating ET to LAI (C_1), a coefficient for soil evaporation (C_2), and a coefficient relating soil moisture content to ET (C_3).

LAI, RDF, and K_c depend on the season and are specified for a number of stages. To model the annual variation in ET, low LAI, and K_c values are used in the winter season (October through April), with a transition in the spring to maximum values during June through September. Transpiration varies with LAI, and in the winter water is lost only by soil evaporation.

Table 6-1. Vegetation Types and Parameters for the MIKE SHE ET Component

Vegetation ID	Percentage of Model Area	LAI (-)	RDF (m)	K_c (-)	C_1 (-)	C_2 (-)	C_3 (-)	C_{int} (mm)
Xeric grass	22.4	0-1	1.0	0.2-0.5	0.2	0.1	10	0.05
Mesic grass	52.3	0-1	1.0	0.3-0.5	0.2	0.1	10	0.05
Woody riparian	0.7	0-5.0	2.0	0.25-1.5	0.3	0.05	20	0.05
Wetland	3.8	0-3	0.5	0.25-0.8	0.2	0.05	10	0.05
Paved areas/riprap	3.2	1.0	0.0	0.1	0.0	0.0	20	0.01
Landfill	9.1	0-0.5	1	0.4-0.6	0.05	0.2	10	0.05
Mudflat/open water	1.1	0.1-3	0.5	0.25-0.5	0.2	0.4	10	0.05
Disturbed/developed	7.4	0-0.5	1	0.4-0.6	0.05	0.2	10	0.05

To simulate the ET rate and seasonal changes observed at the site, the LAI, RDF, and K_c values were specified for each vegetation type from general data on vegetation characteristics at the site. K_c values are important because they are used to directly scale the reference vegetation used in Penmann estimates of potential ET to any vegetation type within the model area. Limited field data are available from literature on the natural vegetation found at RFETS. K_c has been estimated through calibration. K_c may influence the actual ET rate; however, the total ET losses are often limited by water availability (e.g., the soil moisture of the root zone that may be transpired by plants).

The empirical parameters are partially based on method-specific values and single-column model runs. The single-column models tested the range of parameters and empirical constants by looking at simulated infiltration rates, ET losses, and recharge to groundwater.

6.2.2 Climate

Model precipitation and snowmelt are described in the following sections.

Precipitation

Precipitation drives most of the system response at the study area. As a result, it was important to consider its spatial and temporal distribution carefully. Fifteen-minute precipitation from the site meteorological station was used for 1993 and 1994. The interpreted 15-minute precipitation for the Present Landfill area from the SWWB model was used for the first half of 1995 and WY2000. The precipitation was assumed uniform over the Present Landfill model area.

The years 1993 and 1994 had lower precipitation than average, on the order of 12 inches each year. The SWWB-interpreted precipitation had approximately 14 inches of precipitation for the Present Landfill area for spring 1995, one of the wettest on record. The SWWB-interpreted precipitation for the Present Landfill area was approximately 14 inches for WY2000.

The 15-minute precipitation input allows the model to simulate the system response to actual climatic stress. This allows the simulation of the hydrologic processes of overland runoff, flow through the unsaturated zone, ET of soil moisture, and dynamic recharge to the saturated zone. Consequently, the model simulates recharge to the saturated zone for larger precipitation events and when there is no soil moisture deficit. Smaller precipitation events and during times of a soil moisture deficit may not result in saturated zone recharge.

Potential Evapotranspiration

The calculation of PET used daily minimum and maximum temperature, average wind speed, and precipitation. The REF-ET Program (Allen 2000) was used to calculate the PET for a grass reference crop. The PET calculation used the FAO56 version of the standard Penman-Monteith equation. The output was a daily PET amount that was distributed at two-hour intervals for model input. The total PET was evenly divided and applied for a 12-hour period from 7 A.M. to 7 P.M. PET was assumed negligible for the remainder of each day. The PET calculated for the SWWB (K-H 2002a) was used for the 1995 modeling period.

The PET calculation followed the general approach of the SWWB (K-H 2002a). However, several of the inputs used for calculating PET for the SWWB were not available from the Site meteorological data. Therefore, the PET for the WY2000 was recalculated using the SWWB meteorological data and the same methodology as used for the 1993 and 1994 data. The calculated PET for 1993 and 1994 was on the order of

1,600 mm per year. The calculated PET for 1999 was 1,300 mm and almost 1,500 mm for 2000.

Although temporally variable, PET is spatially constant in the model. It varies as a function of topographic slope and aspect; however, the PET is calculated for a horizontal surface for which an average is considered reasonable over the model area.

The ET module of MIKE SHE is an integral part of the unsaturated zone component. ET losses include: (1) interception by the vegetation; (2) evaporation from free water surfaces; (3) soil evaporation; and (4) plant transpiration. The actual evapotranspiration (AET) rate is simulated as a fraction of the specified time-varying potential ET rates. In MIKE SHE, AET represents a "sink" term in either the unsaturated or saturated zone. Unsaturated or saturated zone discharge as AET can vary as a function of depth on specified root zone distributions and depths. Soil evaporation only occurs from the upper numerical grid cell in the unsaturated zone model.

Snowmelt

The numerical model applies a simple degree/day method to determine the rate of snowmelt. The two variables, degree-day factor and threshold value, were set through calibration. The threshold (°C) defines the temperature at which snowmelt can begin. The degree-day factor (mm snow/day/ °C) sets the rate of snowmelt as a function of temperature relative to the threshold value. The values used for the SWWB (K-H 2002a) were used for the Present Landfill model.

Temperature was input uniformly across the Site based on records from the Site Metrology Tower. A large portion (approximately 80 percent) of the 1993 temperature data was missing from the Site Metrology Tower and data from the Boulder, Colorado NCDC station was substituted. The assumption of uniform temperature distribution was necessary based on limited data; however, it fails to take into account the variation of sun exposure for slope orientation or building shadows. Typically, north-facing slopes exhibit slightly longer snow storage compared to south-facing slopes.

6.2.3 Surface Flow

Overland flow was set up in the numerical model to agree with the conceptual model described in detail in Section 1.0. Channel flow is of limited importance at the Present Landfill site due to the absence of inflow to the model area near the landfill. The runoff diversion ditch around the landfill was not simulated.

In the numerical model, overland flow is defined by four main data specifications:

- Initial water depth;
- Depression storage;
- Surface Manning (M); and

- Overland flow areas.

The initial water depth setting specifies the depth of water on the ground surface at the start of the model run. This depth is set at zero in the model, except for the Present Landfill pond, which is reasonable considering the runs were not initiated during intense events. The water depth at the Present Landfill pond was set as the difference between the average water levels in the pond and the pond bottom topography.

Depression storage is the depth of water on the ground surface that must be filled before overland flow will occur. This depth accounts for microtopography and is averaged over the area of each model cell. Depression storage is spatially defined in the model. Based on the SWWB, depression storage is set to 1 mm. In MIKE SHE, depression storage is referred to as "detention storage".

The M-value, with units of $m^{(1/3)}/s$, is a numerical representation of the roughness of the surface. Decreasing M-values represent increasing roughness. A roughness of M=5 was specified for all areas. This value was specified to help account for the large amount of disturbed and partially compacted areas (dirt roads, landfill, dam, and buildings) in the model.

Overland flow areas are the designated overland flow boundaries within the model. These boundaries are applied to account for local topographic and routing features, such as berms that are not captured by the specified topography. The model applies three overland flow areas. These areas were specified based on digital subdrainage delineation of topography.

The MIKE 11 component was not used to simulate channel flow or pond dynamics. There is no persistent surface water at the Present Landfill with the exception of the East Landfill Pond and seep. The overland flow component of MIKE SHE adequately handles the movement of the seep flow to the landfill pond and the standing water of the pond. MIKE 11 was not used to simulate the pond operations due to the use of spray evaporation of landfill pond water prior to fall 1994 as opposed to discrete pond discharges after 1994.

6.2.4 Saturated Zone

Saturated zone model components described in this section include the following:

- Hydrostratigraphic unit and numerical layering;
- Initial and boundary conditions;
- Hydraulic properties;
- Subsurface drains; and
- Subsurface barriers.

Model Layers – Hydrostratigraphic/Numerical

The saturated zone at RFETS has been divided into two hydrostratigraphic units as described Section 4.0. The UHSU consists of the unconsolidated materials and weathered bedrock. The lower hyrostratigraphic unit (LHSU) consists of the unweathered bedrock. Vertical discretization of the model had two aspects. The first was to follow the geologic layers present at the site with unconsolidated material overlying weathered and unweathered bedrock. The second discretization is numerical, where the model vertical discretization is chosen to represent control features in the landfill trench area and for computational purposes.

The saturated zone is vertically discretized into four model layers in the Present Landfill model. Table 6-2 lists the four layers of the model and what material is represented by each layer. The upper layer represents the unconsolidated material outside the landfill and waste material in the landfill. The second layer represents any unconsolidated material beneath the landfill and unconsolidated material outside the landfill. The third layer represents the weathered bedrock. The fourth layer represents the unweathered bedrock.

Table 6-2. Model Layers

Layer	Landfill Area (waste area)	Natural Area (nonwaste area)
1	Waste	Unconsolidated Material
2	Unconsolidated Material/ Weathered Bedrock	Unconsolidated Material
3	Weathered Bedrock	Weathered Bedrock
4	Unweathered Bedrock	Unweathered Bedrock

The unconsolidated material was divided into two numerical layers to allow more accurate depiction of the model processes in the unconsolidated material. The first numerical model layer was made as deep as possible to allow the ET component of MIKE SHE to operate without the water level falling below the bottom of the numerical layer. The second numerical model layer was designed to allow inclusion of possible flow beneath the GWIS and LD where these systems do not extend to the weathered bedrock. Therefore, the bottom of the first numerical model layer was set to the bottom of the landfill or landfill trench if these features were present. Otherwise, it was set to 0.5 m above the weathered bedrock surface. Both Layers 1 and 2 had a minimum thickness of 0.5 m for numerical stability, which resulted in a minor amount of the numerical model layers being pushed into a different geologic layer. An example of this would be a cell in the second numerical model layer beneath the landfill trench where the trench is cut into the bedrock. MIKE SHE accounts for this numerical layer shifting by compositing the hydraulic properties of the numerical layers to account for the relative percentages of the geologic layers included in each cell.

Only one layer was needed to describe the weathered bedrock because Arapahoe sandstone lenses, which immediately subcrop unconsolidated materials elsewhere at RFETS, are not present in the Present Landfill area (DOE 1994). The unweathered bedrock was included to enable the evaluation of flow through that layer near the landfill dam.

The model thickness of the unconsolidated material (Layer 1 and Layer 2) and weathered bedrock (layer 3) are shown graphically on Figure 6-2 and Figure 6-3 respectively. The unweathered bedrock model Layer 4 was set to a uniform thickness of 183 m. Model layer thicknesses were developed by averaging the finer spatial resolution geologic surface information onto the MIKE SHE model grid. Unconsolidated material thickness is greatest in the landfill area (greater than10 m) and thins to the east (less than 2.5 m). The weathered bedrock thickness is mostly in the 2.5-m to 7.5-m range in the model area.

Figure 6-2. Model Unconsolidated Material Thickness

Figure 6-3. Model Weathered Bedrock Thickness

Initial and Boundary Conditions

Boundary conditions are required for the saturated zone portion of the integrated model. Groundwater appears to flow mostly west to east near the Present Landfill. In the southern portion of the study area, groundwater appears to flow southward out of the model domain. To accommodate the groundwater inflow and outflow, constant groundwater levels (pressures) are specified along the boundaries, while they vary spatially along the boundaries based on averaged conditions. Assuming uniform vertical pressure distributions is reasonable given the low vertical gradients at the site. A no-flow boundary condition is assumed for the bottom of the saturated zone.

Initial conditions are important in the integrated model, particularly for the saturated zone. In integrated hydrologic modeling of semiarid conditions, the slow response time of the unsaturated zone, combined with the even slower response of the saturated zone to assumed initial conditions, requires repeated simulation of the fully integrated system to approach quasisteady conditions observed in the saturated system. Initially, the groundwater system stabilizes to conductivity distributions, spatial and temporal recharge response through the unsaturated zone, and assumed initial conditions. Repeated simulations force the system to approach a quasisteady condition. Although repeated simulations, using the same calibration year input stresses (precipitation and PET), do not represent the actual time-varying stresses applied to the system, the system does approach a dynamic state of equilibrium.

The groundwater level data for the study area had temporal and spatial gaps. Therefore, a potentiometric surface (assumed the same for all layers) was constructed using the average groundwater levels from 1993 to 1995 from available wells. This constructed potentiometric surface was used as the initial condition for the simulations. To help stabilize the conditions prior to the calibration period, an additional year with the 1993 climate input was simulated prior to simulating the 1993 to 1995 period.

Hydraulic Properties

Only the saturated hydraulic conductivities and storage coefficients (confined and unconfined) are required in the model. These control the flow rates and transient flow behavior within the saturated zone. These parameters are described below.

Hydraulic Conductivities

The surficial geologic map (Figure 3-1) was used as the basis for the spatial distribution of horizontal hydraulic conductivities within Layers 1 and 2 over the model area outside the landfill area. Horizontal hydraulic conductivities within the landfill for Layer 1 were set for waste material or drainage material (in the LD). Horizontal hydraulic conductivities within the landfill for Layer 2 were set for either unconsolidated materials or weathered bedrock as appropriate. Conductivity values for the weathered bedrock (Layer 3) were set to an average value for the weathered claystones and siltstones at the Site. Conductivity values for the unweathered bedrock (Layer 4) were set to an average value for the unweathered bedrock at the Site. The hydraulic conductivity distributions for Layers 1 and 2 are shown on Figure 6-4 and Figure 6-5, respectively.

Figure 6-4. Model Layer 1 Hydraulic Conductivity Distribution

Figure 6-5. Model Layer 2 Hydraulic Conductivity Distribution

During calibration, conductivities were adjusted primarily in the landfill and the layer beneath the landfill to simulate the observed well response. Locally, the hydraulic conductivity distributions were not adjusted to match individual well responses, but were instead adjusted as an entire geologic unit.

The range of hydraulic conductivities in the calibrated model is shown in Table 6-3. Hydraulic conductivities for the unconsolidated deposits varied from 9.0×10^{-7} m/sec for colluvium to 2.5×10^{-5} m/sec for valley-fill alluvium. At areas where the weathered bedrock geologic layer intersected the numerical model Layer 2, the hydraulic conductivity was set to that of the weathered bedrock (6.1×10^{-8} m/sec).

Table 6-3. Hydraulic Conductivities Applied for the Groundwater Layers

Model Layer	Geologic layer	K_h (m/s)
1	Waste material	2.0×10^{-7} – 1.0×10^{-5}
1 & 2	Unconsolidated deposits	6.1×10^{-8} – 2.5×10^{-5}
3	Weathered bedrock	6.0×10^{-8}
4	Unweathered bedrock	2.5×10^{-9}

The hydraulic conductivity of the waste material was varied depending on the well response. The majority of the waste material was set to a hydraulic conductivity of

$1x10^{-5}$ m/sec. This is higher than the reported values for wells completed in and through the waste. It is within the range of municipal solid waste hydraulic conductivities reported in the literature (Table 3-1). A small stringer of waste was set to a hydraulic conductivity of $1.0x10^{-4}$ m/sec near the SW097 seep to concentrate seep flow. The model grid size of 15.2 m is coarser than the scale of the seep, which allows for some spreading of the seep flow and smoothing out of the topographic features that promote the seep. The enhanced conductivity zone was put in to counter balance these effects. The LD within the waste material was set at $1.0x10^{-3}$ m/sec conductivity. This is conservatively low for gravel.

The weathered bedrock zone was set in the range of the geometric mean of conductivities of weathered claystones and siltstones at the Site. The unweathered bedrock was also set in the range of the geometric mean for unweathered bedrock at the Site.

Storage/Specific Yield

Confined (S_p) and unconfined (S_y) storage coefficients are specified for the four geologic layers, as listed in Table 6-4. The aquifer is unconfined at RFETS and S_y is, therefore, more important in controlling saturated zone behavior. S_y is related to the aquifer porosity, which is relatively low for the near-surface alluvial material. It is lower for the weathered and unweathered bedrock (K-H 2002a).

The S_y values were chosen considering the unsaturated zone soil properties, available Site data, and the magnitude of groundwater rise in response to the April recharge events.

Table 6-4. Storage Coefficients Applied for the Groundwater Layers

Model Layer	Geologic Layer	S_y	S_p
1	Upper unconsolidated deposits	0.10	0.001
2	Lower unconsolidated deposits	0.10	0.001
3	Weathered bedrock	0.01	0.001
4	Unweathered bedrock	0.01	0.001

Subsurface Drains

The GWIS on the outside of the landfill trench was designed as a drain with a sand blanket and a perforated pipe designed to remove groundwater from the subsurface near the landfill. The MIKE SHE code extracts water from the saturated zone with a drain feature and moves the water to another specified location. This required specification of drain cell locations, drain inverts, drain leakage, and discharge locations. For the Present

Landfill model, drains were specified in cells along the outside of the landfill trench. The drain invert was set to the bottom of the landfill trench for that cell based on the as-built drawings of the landfill trench. The drain leakage was set higher than the suggested values in the MIKE SHE manual to account for the permeable sand filter blanket that was installed with the GWIS. The location of the GWIS drain cells is shown on Figure 6-6.

Figure 6-6. Model GWIS Drain Cell Locations

(Attached)

The model grid spacing (15.2 m x 15.2 m) is much larger than the physical drain (1-foot-wide drainage layer and perforated pipe). Putting this feature into the model grid oversimulates the areal effect of the drain. The drain effect on groundwater elevations at the perforated pipe is averaged across the entire model grid.

Subsurface Barriers

There are three distinct sets of subsurface barriers present in the Present Landfill model: (1) the north and south slurry walls; (2) the landfill trench clay barrier; and (3) the landfill dam clay core. These were all represented in the model by the MIKE SHE sheet piling module which allows the placement of a low-conductivity barrier between adjacent cells to control horizontal flow between the cells without reducing the possibility of flow in the cells in other directions. The assigned conductivity of the barrier needs to account for both the conductivity of the barrier material and the thickness of the barrier. The barriers were set with a leakage coefficient of $1x10^{-10}$/sec based on the SWWB results. The barrier leakage was then evaluated during the sensitivity runs.

The LCB was installed on the outer edge of the Landfill Trench System. It consisted of lower-permeability materials that had an approximate horizontal thickness of 10 feet. The landfill trench invert was controlled by the need to maintain a gradient for the LD. It was not tied into the bedrock along its entire length (DOE 1994). The model Layer 1 bottom was fixed to the bottom of the trench invert where the trench was present in the model. Therefore, the slurry wall for the LCB is only present in model Layer 1.

The north and south slurry walls were tied into the LCB and bedrock. The slurry walls extend along the eastern portion of the Present Landfill. They exist in the model in both Layers 1 and 2.

The landfill dam clay core is made of lower-permeability material and tied into the bedrock. It exists in the model in Layers 1 and 2 along the approximate dam centerline.

The model locations of the various subsurface barriers are shown on Figure 6-7.

Figure 6-7. Model Subsurface Barrier Locations

(Attached)

6.2.5 Unsaturated Zone

The unsaturated zone discretization and model parameters are discussed in the following sections.

Vertical Discretization

The numerical solution scheme used to simulate the soil water content and flow in the unsaturated soil columns requires a discretization of the entire column into computational nodes. The discretization must be sufficiently detailed to describe the rapid changes in potential and soil water content following rainfall input to a dry soil, to provide a numerical stable solution given the strong nonlinearities of Richard's equation, and allow a reasonable computation time for the entire integrated model.

The unsaturated zone in the model area varies by the depth to the saturated zone (the lower boundary condition), type of unconsolidated material, and thickness of the unconsolidated material above bedrock. To account for this variability, the model area was broken into zones based on the depth to bedrock. A separate zone was determined for each soil type, with bedrock less than 1.5 m deep, 1.5 to 3.0 m deep, and 3.0 to 4.6 m deep.

The unsaturated zone soil columns are defined from the soil surface down below the lowest groundwater table occurring at any time during the simulation period. The thickness of the unsaturated zone varies throughout the model areas and over time with seasonal fluctuations of the groundwater table. The numerical grid is finest at the ground surface to simulate the infiltration process more accurately. It is also kept relatively fine within the root zone (0.02 to 0.1 m) to avoid numerical instabilities caused by ET. Below the root zone, the grid dimensions increase with depth and are kept constant at 0.4 m, because flow becomes less dynamic and this improves computational efficiency. Vertical unsaturated zone column grid cell sizes range from 0.02 to 0.4 m (0.02 to 0.10 m within the root zone).

Initial and Boundary Conditions

The time scales of flow and changes in the soil moisture content of the unsaturated zone varies from the upper part where changes occur on the order of minutes in response to precipitation, to the deeper sections where the scale of changes for groundwater is on the order of days.

Antecedent soil moisture distribution is important to simulate the key hydrologic processes. If the history of seasonal changes and interannual climate variations are not properly taken into account when specifying initial conditions, there is a risk of overestimating or underestimating the volume of water stored in the unsaturated zone. The additional volume will (if not lost by ET) affect groundwater recharge.

Because the initial soil moisture contents could not be specified from field measurements, a one year "warm-up period" was used in the modeling. The model was run with the 1993 climate data assuming an initial field capacity for a warm-up simulation period of one year to generate a water content distribution reflecting the seasonal state of the hydrologic system (December 1992).

Because one-dimensional flow is assumed, no boundary conditions are needed for the unsaturated component of the integrated hydrological model. The upper boundary shifts automatically from a flux boundary to a head boundary when water starts ponding at the surface. A pressure head corresponding to full saturation is applied at the lower dynamic interface between the unsaturated zone and groundwater.

Hydraulic Properties

The unconsolidated materials have been broadly grouped into the four main surficial deposit material types (Qrf, Qc, Qvf, and af) shown on the surficial geologic distribution (Figure 3-1). The colluvium (Qc) includes all material types except the Rocky Flats Alluvium (Qrf). The valley-fill alluvium (Qvf) includes the Piney Creek Alluvium (Qp) and terrace deposits (Qt). The artificial fill (af) on the surficial geologic map was assumed to be the surrounding geologic material except for the landfill area.

The broad hydraulic property zonations were specified in the model primarily to address regional differences in unsaturated zone properties that might affect surface infiltration and groundwater recharge. The limited unsaturated zone data described in the SWWB (K-H 2002a) prevent definition of a higher number of material types in the model. As such, the hydraulic properties represent effective values over the extent of each model cell. Using fewer soil types reduces the degrees of freedom in the integrated model, making the process of calibration more manageable (Refsgaard 1997). Over the vertical extent of the unsaturated zone, hydraulic properties are assumed homogenous above the bedrock contact.

Four "soil" types were defined in MIKE SHE for use in the unsaturated zone calculations (UZ module).. Although unsaturated flow parameters vary within each of the four soil types, it is not possible to consider this variation in the model. Furthermore, available field data did not justify adding more soil types. Effective unsaturated zone parameter values of the soil zones are summarized in Table 6-5.

Table 6-5. Unsaturated Zone Hydraulic Properties

Soil Profile ID	Description	θ_s (-)	θ_{fc} (-)	θ_w (-)	K_s (m/s)	n (-)
Qrf#58	Rocky Flats Alluvium	0.30	0.24	0.23	$1x10^{-4}$	5
Qc West	Colluvium (west section)	0.37	0.18	0.16	$1x10^{-5}$	15
Qal#3	Valley-fill alluvium	0.40	0.35	0.17	$5x10^{-5}$	20
Waste	Mixed waste and daily cover	0.30	0.13	0.08	$1x10^{-5}$	5

The waste soil type parameters are a lumped category based on literature values for unsaturated zone modeling for landfill leachate recirculation (Reinhart and Townsend 1998) and the modeled values for the daily cover material, which has been estimated to compose 30 percent of the landfill volume (DOE 1994).

Soil moisture retention characteristics were specified for each soil in MIKE SHE. These data are defined by the water content (θ) as a function of capillary pressure, $\Psi(\theta)$. Other unsaturated data specified for each soil in the code include: (1) water contents at field capacity (θ_{fc}); (2) wilting point (θ_w); (3) saturation (θ_s); (4) saturated hydraulic conductivity (K_s); and (5) an exponent controlling the shape of the $K(\theta)$ curve.

During calibration, K_s and θ_{fc} were adjusted to provide a balance between overland flow contributions caused by insufficient infiltration capacity, soil moisture profiles, ET losses, and groundwater recharge. Groundwater table observations indicate that the majority of recharge occurs in April, which was used to derive the unsaturated zone parameters.

7.0 INTEGRATED NUMERIC MODEL PERFORMANCE

The performance of the integrated MIKE SHE model is described in this section. Model performance is demonstrated in three steps: calibration, model validation, and sensitivity analysis. In the calibration process, discussed in Section 7.1, key model input parameters are adjusted to reproduce various observed system responses.

Model performance was further validated using climate conditions for the post-calibration time period. The sensitivity analysis was conducted to demonstrate the model performs reasonably and determine which model inputs affect system responses the most in focus areas.

7.1 Model Calibration

The integrated model for the Present Landfill was calibrated using an approach similar to that described in the SWWB modeling report (K-H 2002a). The model was then run using spatial and temporal interpretations of the actual external stresses. The model simulates various types of system output that are then compared to observed system response data. Model input is then adjusted iteratively, to reduce the difference, or residual, between simulated and observed response. This procedure is followed until the simulated and observed responses are reasonably close.

Calibrating an integrated model is more complex than calibrating a single-process model, such as a saturated zone groundwater flow model. As such, less emphasis is placed on pre-defining a set of calibration target levels. Instead, more emphasis is placed on demonstrating that the integrated model response is realistic.

The success of the calibration process depends on the quality and quantity of available input stresses, initial model parameters, and system response data. System response data are typically referred to as calibration targets, and initial estimates of model parameters adjusted during the calibration process are referred to as calibration parameters (ASTM 1993).

Calibration targets typically only consist of measured system response data. However, in an integrated model, other less quantitative response data can also be used in the calibration process. For example, seep areas, or general losing or gaining reaches along streams, represent semiquantitative system response.

Calibration parameters adjusted in the integrated Present Landfill model included hydraulic conductivity, GWIS drain leakage, unsaturated zone properties, and vegetation parameters. Other types of model input typically not adjusted during model calibration include data such as geologic surfaces or topography. These are not adjusted because they are generally known more reliably over the model area, or do not affect flows as much as the selected calibration parameters.

A comparison of simulated and observed system response (calibration targets) is described in Section 7.2. Other types of simulated system response are described in Section 7.2.3.

7.2 Comparison of Simulated and Observed Response

Model calibration was measured by comparison of simulation results and observed data. For the calibration period, observed quantitative data include:

- Groundwater levels; and
- Approximate seep flow rates.

The following sections present the calibration results with a discussion of model performance and applicability.

7.2.1 Surface Water

The model predicts very minor amounts of overland flow. This flow is concentrated at the seep area (SW097) flowing into the landfill pond. A minor amount of overland flow is predicted in No Name Gulch and the northern tributary of No Name Gulch, because these areas have shallow bedrock depths and the surface topography is steep. There is some predicted overland flow in the southwestern portion of the site toward the North Walnut Creek drainage where bedrock depths are very shallow. The cumulative simulated overland flow for 1994 is shown on Figure 7-1. Constant head cells in the East Landfill Pond area were specified to simulate the pond itself, so the overland flow in this area simply reflects effects of these constant head cells.

Figure 7-1. Model Overland Flow - 1994

(ATTACHED)

7.2.2 Groundwater

The modeled response for groundwater heads and discharges is described in the following sections.

Groundwater Levels

Groundwater level data for 1994 were chosen as the principal model calibration targets. A secondary set of calibration criteria, represented by the temporal water level trends in individual wells, is also used to constrain the model calibration. As discussed in Section 3.0, groundwater levels vary seasonally, but have a reasonably consistent yearly average. A noticeable increase was seen in most wells during the very wet spring of 1995. Very few wells were present in the western portion of the study area until after 1995. Some wells in the study area had data for 1993 but not for 1994. To obtain the largest spatial distribution of calibration targets, the calibration data set was constructed of the following: (1) 1994 average groundwater elevations for wells with this data; (2) 1993 average groundwater elevations for wells removed in 1993; and (3) groundwater average elevations for wells installed after 1994.

The calibration focused on wells completed in alluvium or across the alluvium/bedrock contact. Seventy-one wells were considered for the calibration effort. Many of the bedrock wells appeared to be impacted by sampling and are likely biased low.

The spatial distribution of groundwater residuals for the 1994 period is shown on Figure 7-2. Many of the wells are within 1 m of the annually averaged groundwater depths. The spatial distribution of groundwater residuals is reasonable, showing little bias of residuals to positive or negative values. This is further supported in a graphical plot of the modeled versus measured depths to water levels shown on Figure 7-3. The groundwater residuals were calculated from depth-to-water measurements. The average measured depth to water, period of measurement, and residuals are shown in Table 7-1. The wells had a root mean square of residuals (RMSR) of 1.17 m and the average residual was 0.21 m for the calibration heads.

Figure 7-2. Average Model Groundwater Head Residuals - 1994

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Figure 7-3. 1994 Groundwater Residuals

(ATTACHED)

Table 7-1. Calibration Well Residuals

(Attached)

The temporal response for the 1993 to 1995 model period for selected wells is shown on Figure 7-4 and Figure 7-5. These wells were chosen for their spatial distribution in the landfill waste, near the landfill, and downstream of the dam. It can be seen that the landfill wells (72293, 6487, and 71493) demonstrate the damped response of the system. The natural system wells near the landfill (1086, 6087, and 70693) show a more amplified response with a good match on the timing and magnitude of response to recharge events and a good sensitivity to the normal ET stress on the system. The wells downstream from the dam (4087 and 4287) show a good response on timing and magnitude to recharge events and are sensitive to the ET stress.

Figure 7-4. Modeled Well Response

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Figure 7-5. Modeled Well Response

(ATTACHED)

Modeled vertical flows between Layers 1 and 2 and Layers 2 and 3 are shown on Figure 7-6 and Figure 7-7, respectively. The majority of the vertical flow in the model layer 1 is downward (negative). Upward vertical flows (positive) occur near the East Landfill Pond boundaries, the SW097 seep area, and No Name Gulch and the drainages leading into No Name Gulch. Upward flow also occurs along the northwestern model boundary where the topography descends into the North Walnut Creek drainage. The effect of the landfill GWIS and LD systems is seen in the model, with both systems drawing flow from Layer 2.

Figure 7-6. Modeled Vertical Flows from Layers 1 to 2 (1994)

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Figure 7-7. Modeled Vertical Flows from Layers 2 to 3 (1994)

(ATTACHED)

The cumulative simulated vertical flow from model Layers 2 to 3 for 1994 is shown on Figure 7-7. Groundwater flows downward over the majority of the model area. Upward vertical flow is again predicted near the pond, seep area, and No Name Gulch and the drainages leading into the gulch. The modeled landfill GWIS and LD systems produce upward flow from Layers 3 to 2 (weathered bedrock to overlying unconsolidated material).

Groundwater Flow Directions

Modeled mean groundwater flow directions for 1994 are shown on Figure 7-8, Figure 7-9, and Figure 7-10 for model Layers 1, 2, and 3, respectively. It is important to note that these figures are scaled based on the largest flow vector for each layer and a multiplication factor large enough to exhibit flow vectors for that figure. Some areas without obvious flow vectors may either be predicted as dry in the model, or, more likely, very small flow amounts compared to the maximum flow areas. The flow vectors give an indication of the mean modeled flow directions and relative magnitude of groundwater flow in that layer. The flow vectors are comparable across layers.

Figure 7-8. Modeled Horizontal Flow Layer 1 (1994)

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Figure 7-9. Modeled Horizontal Flow Layer 2 (1994)

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Figure 7-10. Modeled Horizontal Flow Layer 3 (1994)

(ATTACHED)

The flow vectors give an understanding of the predicted groundwater flow directions in the model. They can be compared to the conceptual understanding of the groundwater flow directions based on the interpreted data presented in Section 3.0.

The model simulates flow along the LD in Layer 1 with relatively larger amounts of flow along the southern portion of this system. Groundwater flow upgradient and exterior to the landfill wastes is drawn toward the GWIS drain. This indicates that groundwater levels are at least high enough in Layer 1, exterior to the landfill waste, to be controlled by the GWIS drain, if it is actually functional as conceptualized in the current model. In general, the majority of groundwater within the landfill waste material flows toward the LD, and only the central upgradient area of the landfill is actually directed toward the seep. Flows are highest near the vicinity of the seep area (SW097).

The model simulates groundwater flow toward the LD and GWIS along much of the western landfill boundary. Very little groundwater flows through the north and south landfill slurry walls. The majority of flow in Layer 2 in the landfill is in the centerline of the eastern portion of the landfill, with water flowing to the SW097 seep and landfill pond. Groundwater flow also occurs in No Name Gulch below, and to the northern portion of the landfill dam.

In Layer 3, the model simulates flow toward the LD and GWIS along much of the western landfill boundary. Again, this flow shows the modeled influence of these systems. A relatively large portion flows toward the landfill pond, toward the northern tributary of No Name Gulch, and on the northern portion of No Name Gulch below the landfill pond.

Overall, simulated groundwater flow directions appear reasonable, with flow going to the discharge points of the landfill seep (SW097), East Landfill Pond, and the other topographic discharge points.

Seep Discharge

In MIKE SHE, seep flow is calculated as water discharging from the saturated zone to overland flow. The modeled seep flow for SW097 shows seasonal variation ranging from 1.5 to 3 gpm and averaging 2 gpm for the simulation period. The simulated temporal response is shown on Figure 7-11. The model seep flow closely matches the average estimate of approximately 2.5 gpm (Section 3.5.1).

Figure 7-11. Modeled SW097 Seep Flow

(ATTACHED)

All of the areas in the model that produced flow from the saturated zone are shown on Figure 7-12. The model predicts a net seep flow at SW097 and the area immediately east of SW097. Flow into the pond is shown and relatively small amounts of seep flow along No Name Gulch and the northern tributary of No Name Gulch are also shown.

Figure 7-12. Modeled Seep Areas (1994)

(ATTACHED)

GWIS Drain Discharge

The modeled GWIS discharge rates are shown on Figure 7-13. Including the large increase in the modeled discharge rate in 1995, the average modeled discharge is approximately 3.3 gpm. The modeled discharge shows seasonal variation as it responds to precipitation events. The cumulative model predicted volumes for 1994 are shown on Figure 7-14. The predicted groundwater discharges to the GWIS are largest in the west and decrease along the southern portion of the system.

Figure 7-13. Modeled GWIS Discharge Rates

(ATTACHED)

Figure 7-14. Modeled GWIS Volumes (1994)

(ATTACHED)

The GWIS is modeled as a set of drains that discharge the intercepted water outside the model. As discussed in Section 0, the actual GWIS discharge points are not clearly known. The modeled GWIS setup is one possible interpretation of how to handle the system. Another possible interpretation is flow along the GWIS to the lowest elevation on the system (to the east) and then removal of the water from that location. Additionally, the intercepted water could be routed to the East Landfill Pond or No Name Gulch.

The model interpretation was designed to evaluate the potential system response if the GWIS is operating as designed. The model residuals (Figure 7-2) show a reasonable response at the western end of the GWIS. Further along the system, the modeled response is lower on the outside of the GWIS than actual values. Further east, the modeled response is again close to measured groundwater elevations. Some of the model response to the GWIS is due to the spatial scale of the model grid. A well that is near the GWIS may share a model grid with the system, depressing the simulated groundwater levels at the well.

It is also important to recognize that the LD system in the model has the potential to affect the effectiveness of the GWIS at draining external groundwater inflows because of the potential flow pathway beneath the trench system through alluvium, or in some cases weathered bedrock. The degree to which the LD might affect GWIS operation depends on the local hydraulic properties of material beneath the trench system, as well as the relative efficiency of the LD and GWIS.

One of the sensitivity runs assumed the GWIS was not functioning (Section 7.4). The residuals for this model run are shown on Figure 7-15.

Figure 7-15. No GWIS System Model Groundwater Head Residuals (1994)

(ATTACHED)

Water Balance Data

The model-wide water balance for 1994 is shown on Figure 7-16. As in the SWWB modeling (K-H 2002), the landfill model's water balance is dominated by precipitation and ET. Overland boundary outflow is negligible. There is a drop in the subsurface storage. Subsurface boundary outflow is approximately 50 percent more than the subsurface boundary inflow. The GWIS drainage system removes approximately one-third of the subsurface boundary outflow.

Figure 7-16. Modeled Water Balance for 1994

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A water balance was calculated for each focus area shown on Figure 5-2. A summary for each area is shown on Figure 7-17. Within the landfill area the majority of precipitation is removed by ET. The remaining precipitation recharges the saturated zone. The saturated zone discharges to the SW097 seep. The model shows seep flow to be slightly larger than the recharge for 1994, with the remainder made up by a reduction in storage. There is a minor amount of subsurface boundary inflow.

The SW097 seep catchment water balance is dominated by the subsurface boundary inflow that then leaves this catchment area as overland flow. The landfill pond catchment includes ET from the vegetation surrounding the pond and evaporation from the ponded water being the dominant sink term. There is overland boundary inflow from the SW097 seep area. There is slightly more modeled subsurface boundary inflow than outflow for the pond catchment.

ET loss is approximately 50 percent greater than total precipitation in the downstream dam catchment area due to the riparian vegetation and subsurface inflow to the area.

Figure 7-17. Focus Areas Modeled Water Balances (1994)

(ATTACHED)

7.2.3 Additional Simulated System Response

Modeled overland flow, ET, groundwater recharge, and groundwater discharge across model boundaries, as well as simulated numerical error, are described in this section.

Overland Flow

The amounts of overland flow generated by the model for 1994 are shown on Figure 7-1. The model predicts overland flow at and near the landfill SW097 seep where the bedrock surface is very shallow. Additional flow is predicted in No Name Gulch and its tributaries where topographic lows are present.

Actual Evapotranspiration

Modeled AET is shown on Figure 7-18. The predicted AET amounts are highest around the landfill pond and No Name Gulch and its tributaries where groundwater is shallow due to near-surface bedrock. A higher density of riparian vegetation occurs at these locations, which is effective at removing the shallow groundwater.

Figure 7-18. Modeled Total AET (1994)

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Groundwater Recharge

The simulated distribution of annual groundwater recharge (mm/year) is shown graphically on Figure 7-19. Recharge is an important process to consider in simulating the integrated response of the system because it controls the groundwater flow and also reflects unsaturated zone conditions, including effects of ET. Positive values indicate that recharge to the saturated zone occurs, while negative values indicate that groundwater discharge occurs. ET is greater than recharge.

Negative recharge rates occur along No Name Gulch and its tributaries, near the SW097 seep area, and some of the mesa areas. The simulated recharge rates in the landfill area are on the order of 50 mm/year. This is higher than the 25 to 41 mm/year assumed in previous reports. The integrated model allows a simulation of the wetting front percolating into the landfill, versus making an assumption about the recharge rates. The simulated recharge in the landfill area is consistent with the rates reported for that area in the SWWB (K-H 2002a).

Figure 7-19. Modeled Total Recharge (1994)

(ATTACHED)

Groundwater Discharge

The relative lateral groundwater discharge can be seen on Figure 7-8, Figure 7-9, and Figure 7-10. Modeled groundwater boundary discharge tends to follow the topography, with discharges into the North Walnut Creek drainage to the south and No Name Gulch to the east.

Simulated Numerical Error

The total combined numerical error for the MIKE SHE model process (overland flow, unsaturated zone flow, saturated zone flow, and snowmelt) is shown on Figure 7-20. In general, errors were small compared to the total mass balance. Locally, errors were higher along the southern model boundary, near the SW097 seep area, and at the connection of the south slurry wall and landfill trench.

Figure 7-20. Total Annual Numerical Error (1994)

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7.3 Model Validation

The calibration effort considered model performance only for the range of conditions observed from 1993 to mid-1995. Model validation consisted of testing the model against an additional period of climatic record that was not used in the calibration. As such, this validation was an additional assessment of the numerical model performance to determine whether the calibrated parameters are close to the actual values. The approach and findings of the validation run are presented and discussed below.

7.3.1 Approach

The validation period chosen was WY2000 (October 1999 to September 2000). This period was chosen based on the climatic and system response information available. This section briefly discusses the validation period climate, validation model development, and the data limitations.

The model was modified in two major ways. The topography for the Present Landfill area had changed due to continued landfill operations. The landfill was regraded and reseeded in 1998 when landfill operations ceased. The model topography was adjusted in the landfill area to reflect the regarded surface. The vegetation distribution in the landfill area was changed to a modified mesic vegetation. The seeding of the landfill most closely resembles the native mesic vegetation (K-H 2000). Because the landfill was recently reseeded, the LAI of the model vegetation on the landfill was reduced to 75 percent of the normal LAI in the landfill area.

Climatic data for WY2000 was prepared as part of the SWWB (K-H 2002a). The calculation of PET for this data involved variables not available for the calibration period of the Present Landfill model (see Section 3.1.1). For consistency, the PET was calculated for WY2000 using the same methodology as for the 1993-1994 climate data. The daily PET predicted by the REF-ET program was then divided over the 12-hour period from 7 A.M. to 7 P.M. each day. The REF-ET program predicted a decreased amount of PET (roughly 15 percent) for WY200 as compared with the 1993 - 1994 PET amounts. This appeared to be due to temperature and precipitation differences between the two periods.

The validation model run was hot started from the calibration model September 1993 conditions. This allowed the simulation to start from a system where the unsaturated zone conditions had stabilized.

7.3.2 Results

The validation model residuals for the WY2000 are shown on Figure 7-21. There are fewer wells with water level data during this period and no wells present within the landfill during this time. The wells outside the landfill show good agreement near the landfill boundary. Simulated water levels are slightly high in No Name Gulch. The residuals are plotted on Figure 7-22 and summarized in Table 7-2. Well 1297 had two total measurements during this time period that varied by 7 m. Without this well, the 31 calibration wells had a RMSR of 1.37 m.

Figure 7-21. Validation Model Groundwater Residuals (WY2000)

(ATTACHED)

Figure 7-22. WY2000 Model Groundwater Head Residuals

(ATTACHED)

Table 7-2. Calibration Groundwater Residuals

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The average modeled seep flow at SW097 was 3.7 gpm. The GWIS discharge, as predicted by the model, averaged 5 gpm.

The model showed a reasonable response to the WY2000 climate simulation. The model is sensitive to climate and the driving forces of precipitation and ET.

7.4 Model Sensitivity Analysis

A sensitivity analysis was conducted using the calibrated Present Landfill model primarily to establish which model parameters control the hydrologic flow response for the Present Landfill system. Several "what-if" scenarios were run where subsurface structures (GWIS and LCB) were taken out. In addition, general simulated system response was assessed mainly in the focus areas through this analysis to demonstrate model performance. The sensitivity of various different model output to input parameters was considered within these focus areas. A brief summary of the approach and results of the sensitivity analysis are presented in this section.

7.4.1 Approach

Through calibration, a subset of the total number of model parameters was identified for the sensitivity analysis. All possible combinations of the selected key parameters were not considered because of the number of simulations this would require and the complex integrated response. Instead the parameters were changed one by one to isolate the effect of individual parameter, and all other parameters were unchanged corresponding to the calibrated model parameter set. The majority of the sensitivity runs were conducted on reduced model catchments that focused on the landfill area or the landfill and downstream of the dam. The reduced catchments were used to conduct more model sensitivity runs focusing on the core landfill area.

The sensitivity runs conducted are listed in Table 7-3.

Table 7-3. Model Sensitivity Simulations

(Attached)

The ranges of parameter values considered in the sensitivity analysis were selected based on observed RFETS data ranges and publications on parameter ranges in general. A total of 23 sensitivity runs were completed changing one model parameter at a time. Additionally, three "what – if" scenarios were completed. The parameters that were considered include:

- Saturated zone hydraulic conductivity;
- Landfill material hydraulic conductivity;
- GWIS leakage coefficient;
- LD conductivity;
- Landfill material porosity;
- Slurry wall leakage (LCB, north and south slurry walls, and landfill pond dam core) coefficients; and
- Landfill pond water levels.

The "what-if" scenarios assumed there was no GWIS in operation, a GWIS was blocked at the pipe connection between the perforated pipe and the solid discharge pipe, no LCB, and no Landfill Trench System.

Given the coupled processes of an integrated model, it is important to stress that model responses may exhibit local "discontinuities" or "thresholds" which implies that parameter sensitivity may depend on the absolute value of the parameter itself, correlation with remaining parameters, and the model state variables. Certain model responses (e.g., drain runoff) are triggered at groundwater levels above the specified drain levels, in which case the generated runoff influences the water balance, whereas it would have no effect when the groundwater table is lower than the drain level. The parameter ranges in the calibrated model were assumed physically realistic, and hence the analysis describes model sensitivities only in this part of the parameter range.

A number of relative and comparative measures were applied to evaluate the sensitivity at points of importance, namely:

- Changes in discharge at SW097 and the GWIS drainage volumes; and

- Groundwater level sensitivity for mean 1994 modeled levels (changes in the landfill area and below the landfill dam).

7.4.2 Results

The comparative results of the sensitivity model runs are shown in Table 7-4. The table is color coded by the system response.

Table 7-4. Model Sensitivity Simulations

(Attached)

SW097 Seep Flows

Modeled SW097 seep flow had an increase of 10 percent or greater for increased saturated conductivity of the waste material, LD material, external soil, and weathered bedrock; conductivity of unsaturated waste; and low porosity of waste material. Seep flow decreased by 10 percent or more for a lower saturated conductivity of the waste material, lower conductivity of unsaturated waste material, higher porosity of the waste material, and lower hydraulic conductivity of the layer underlying the waste material. Other parameter changes had a marginal effect on the modeled SW097 seep flows.

The modeled seep flow increased for the "what-if" scenarios of no GWIS and the GWIS blocked at the end of the perforated pipe section. The modeled seep flow decreased for the "what-if" scenario of no Landfill Trench System.

Modeled GWIS Drainage

Modeled GWIS drainage increased by 10 percent or more for higher conductivity of the unconsolidated materials outside the landfill the weathered bedrock. The modeled drainage decreased by 10 percent or more for lower GWIS leakage coefficient, lower conductivity of the external unconsolidated materials, lower waste unsaturated conductivity, higher porosity of the waste material, and lower conductivity of the material underlying the waste.

Landfill Groundwater Levels

The mean modeled groundwater elevations for 1994 increased for the simulations with lower saturated conductivity of the waste material, increased conductivity of the external unconsolidated materials, increased waste material unsaturated conductivity, lower porosity of the waste material, and decreased conductivity of the material underlying the landfill. The modeled elevations decreased for simulations with higher waste material conductivity, higher conductivity of the weathered bedrock, lower conductivity of the unsaturated waste material, and higher porosity of the waste material.

The modeled groundwater elevations increased for the "what-if" scenarios of no GWIS, the GWIS blocked at the end of the perforated pipe section, and no Landfill Trench System.

Below Dam Groundwater Levels

The mean modeled groundwater elevations for 1994 increased for higher dam slurry wall leakage, higher conductivity of the unconsolidated materials, higher conductivity of the weathered bedrock, and higher conductivity of the unweathered bedrock. Modeled groundwater elevations decreased for lower conductivity of the unconsolidated materials and the weathered bedrock.

No Landfill Trench System Simulation

One of the "what-if" scenarios was the absence of all the components of the Landfill Trench System (GWIS, LCB, and LD). The groundwater residuals from this model run are shown on Figure 7-23. The groundwater residual distribution is very similar to the calibrated model simulation outside the landfill area. In the landfill area, the model overpredicts groundwater elevations in most places, especially in the western portion of the landfill. This suggests that the Landfill Trench System is operating in this portion of the landfill.

Figure 7-23. No Landfill Trench System Groundwater Residuals (1994)

(ATTACHED)

The modeled mean groundwater flow directions for 1994 are shown on Figure 7-24, Figure 7-25, and Figure 7-26 for model Layers 1, 2, and 3, respectively. It is important to note that these figures are scaled based on the largest flow vector for each layer and a multiplication factor large enough to exhibit flow arrows for that figure. The flow vectors give an indication of the mean modeled flow directions and relative magnitude of groundwater flow in that layer. The flow vectors are not comparable across layers.

The modeled flow vectors show groundwater moving from west to east across the landfill area. The groundwater flow within the landfill then concentrates near the SW097 seep discharge location.

The modeled seep discharge for this case averaged 1.5 gpm or 75 percent of the baseline model. A water balance for the simulation without the Landfill Trench System showed discharge from the SW097 seep location being approximately 90 percent of the groundwater recharge over the landfill area.

Figure 7-24. No Landfill Trench System Modeled Horizontal Flow Layer 1 (1994)

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Figure 7-25. No Landfill Trench System Modeled Horizontal Flow Layer 2 (1994)

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Figure 7-26. No Landfill Trench System Modeled Horizontal Flow Layer 3 (1994)

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8.0 HYPOTHETICAL SCENARIO

A hypothetical scenario was run to evaluate the impacts of a potential closure scenario for the Present Landfill. This scenario was requested by ER personnel.

8.1 MODEL SETUP

The topography and vegetation of the Present Landfill area has changed since the calibration period of 1993 to mid-1995. To evaluate the potential change in the system hydrology for the hypothetical scenario, it was necessary to run a new baseline simulation that had the current topography (1999) and the vegetation distribution of the validation model. This baseline model was run with the calibration climate input of 1993 to 1994. The hypothetical scenario was then run with appropriate modifications to the topography, and the assumption of the landfill being fully vegetated with mesic vegetation. The future scenario was then run with a hypothetical wet climate.

8.1.1 Structural Modifications

The hypothetical scenario has an assumed 1 foot of additional cover material over the Present Landfill area. This additional cover material has the modeled unsaturated hydraulic properties of Rocky Flats Alluvium and a saturated hydraulic conductivity of $1x10^{-5}$ cm/sec. The portion of the model with the additional cover material is shown on Figure 8-1.

Figure 8-1 Modified Areas Present Landfill

(Attached)

8.1.2 Climatic Conditions

The baseline run and hypothetical scenario both used the 1993 and 1994 climate sequence to calibrate the model. The development of this climate sequence is described in Section 6.2.2. A "wet year" climate sequence from the SWWB (K-H 2002a) was used to pertubate the system to simulate climatic uncertainty. This wet year sequence was the WY2000 precipitation multiplied by a factor to generate a wet year of precipitation. This WY2000 precipitation was then mapped to the period of October 1993 to November 1994.

8.1.3 Initial/Boundary Conditions

For the hypothetical scenario, initial groundwater levels, developed by simulating two full years, were used in the simulation to stabilize unsaturated zone conditions. Because the two runs were made using the same initial conditions, simulated differences between the two models reflect only the effects of modifications, rather than the initial conditions.

The boundary conditions for the surface and groundwater flow systems were the same as the calibration model. Constant groundwater levels were specified on the model boundaries, and for the landfill pond.

8.2 HYPOTHETICAL SCENARIO SIMULATION RESULTS

The model outputs were for the climate period October 1993 to November 1994 (WY1994). This different output period from the calibration model results (calendar year 1994) was chosen to utilize the "wet year" climate that had been specified for a water year.

8.2.1 Change in Groundwater Levels

Groundwater levels in the landfill focus area were approximately 0.6 m lower in the scenario with the additional cover material and full vegetation than in the baseline model run. This is attributed to less modeled recharge in the landfill focus area. The wet year simulation had mean groundwater levels in the landfill focus area approximately 0.5 m lower than in the baseline model run.

8.2.2 Seep Flow

The modeled seep flow decreased slightly more than 10 percent in the scenario run from the baseline run. The modeled seep flow for the wet year simulation was effectively the same as the baseline run.

8.3 UNCERTAINTY ANALYSIS

The primary purpose of simulating the hypothetical scenario was to predict hydrologic responses that result from the changing cover material and vegetation on the Present Landfill. An uncertainty analysis is usually conducted to determine the uncertainty of these model predictions given the uncertainty in different model input. It was requested that the uncertainty analysis for the hypothetical scenario be limited to the wet year climate simulation.

8.4 LOW-PERMEABILITY MATERIAL SIMULATION

An additional simulation was conducted using a 1.5-foot, low-permeability layer over the waste material for the calibrated model. This simulation was run for the calibrated model climate sequence to evaluate the potential effects of reduced recharge to the landfill system.

8.4.1 Simulation Results

The modeled mean groundwater flow directions are shown on

Figure 8-2 and Figure 8-3 for model Layers 1 and 2, respectively. It is important to note that these figures are scaled based on the largest flow vector for each layer and a multiplication factor large enough to exhibit flow arrows for that figure. The flow vectors give an indication of the mean modeled flow directions and relative magnitude of groundwater flow in that layer. The flow vectors are not comparable across layers.

The modeled flow vectors show groundwater flow concentrated in the center of the landfill and along the southern arm of the LD in model Layer 1. Groundwater flow is more evenly distributed in model Layer 2, with groundwater flow going toward the landfill. Groundwater from the landfill area discharges at the SW097 seep area.

Modeled recharge in the landfill area was approximately 10 percent of the calibrated model. Average modeled seep flow for this simulation was 1.5 gpm. This is approximately 75 percent of the calibrated model run. The model shows the seep flow being met by an increased amount of water coming as horizontal and vertical inflow and a decrease in storage in the landfill area. The groundwater levels in the landfill area dropped by an average of 0.5 m from the calibrated model.

Figure 8-2. Reduced Recharge Modeled Horizontal Flow Layer 1

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Figure 8-3. Reduced Recharge Modeled Horizontal Flow Layer 2

(ATTACHED)

9.0 SUMMARY AND KEY FINDINGS

Information for the Present Landfill modeling project was derived principally from available reports in the ER library, Site-wide well data, and data collected for the SWWB (K-H 2002a). Background on available landfill-related data and history is presented in Section 2.0, while available data and their interpretation used to develop an integrated conceptual flow model for the landfill are presented in Section 3.0. From the compiled information, a conceptual model of the hydrologic system at the Present Landfill was constructed and is presented in Section 4.0.

A numerical model was then constructed using the integrated flow code MIKE SHE using an approach outlined in Section 5.0. Details of the integrated numerical design of the MIKE SHE flow model for the Present Landfill are presented in Section 6.0, while the actual model performance is described in Section 7.0. The numerical model focused on the Present Landfill and surrounding areas. Geologic surfaces for the top and bottom of the weathered bedrock zone were interpreted based on the most complete compilation of historical boring information to date. Extent and thickness of the waste material from previous work was incorporated into the model. In addition, key landfill control structures (GWIS, LCB, LD, and slurry walls) were also included in the model design. Published vegetation distributions for the 1993 to mid-1995 and 2000/2001 time periods (K-H 2002a) were converted into hydrologically significant categories and used in the model for calibration and model validation. The REF-ET Program (Allen 2000) was used to calculate the PET using the FAO56 version of the standard Penman-Monteith equation for 1993 and 1994 Site climatic data.

The model was calibrated using data for the 1993 to mid-1995 period. This period was chosen because it was the latest historical period of water level measurements within the Present Landfill boundary, and spring 1995 was an extremely wet period with substantial system response. Model calibration focused on matching average 1994 groundwater levels, timing and magnitude of system response at wells, and the seep flow at SW097.

Following model calibration, a sensitivity analysis was conducted to establish which model parameters dominate the hydrologic flow response for the Present Landfill system. Model sensitivity to hydraulic conductivity, leakage coefficients, landfill material properties, and pond water levels was evaluated for seep flow, modeled GWIS discharge, and groundwater levels.

The model was run for a validation period of WY2000 with the topography modified to the current land surface at the landfill and the vegetation coverage revised to reflect that the landfill area had been reseeded in 1998. The model was found to be sensitive to the WY2000 climate change and vegetation changes but simulates system response reasonably well.

In Section 8.0, a hypothetical scenario was run to evaluate the possible impacts of a potential closure scenario for the Present Landfill. This scenario modified the surface in the landfill area by adding 0.3 m of cover material and having the landfill area be fully vegetated with mesic vegetation. This simulation was compared to a simulation with the landfill not having the additional cover and less established vegetation. These simulations were run for the calibration model climate years of 1993 and 1994. An additional run was performed with the wet year precipitation from the SWWB (K-H 2002a) to evaluate impacts of a wetter climate on the landfill system.

9.1 KEY FINDINGS

The primary purpose of developing a flow model was to better understand the past, current, and possible future integrated hydrologic conditions to support a detailed water quality analysis in the Present Landfill area. The amount of modeling output generated through development and application of the integrated Present Landfill model is substantial and provides new insight into the integrated and dynamic hydrologic behavior within and surrounding the Present Landfill area. Key findings include the following:

- The calibrated integrated model reproduces observed annual landfill seep (SW097) flow location and discharge, and key spatial and temporal well water level response to annual recharge events and ET reasonably well.

- The model shows that observed seep flow and water level data are best simulated when the Landfill Trench System (i.e., the GWIS, LCB, and LD) is assumed to be functional.

- Modeling shows that groundwater interior to the trench system flows outward to the LD and is then routed toward the former West Landfill Pond area. Exterior groundwater is intercepted by the GWIS and directed away to either the landfill pond or No Name Gulch. The LCB prevents exterior and interior flows from mixing.

- The model shows that water in the landfill waste material is derived mostly from direct recharge of precipitation over the waste material (greater than 90 percent), rather than lateral or vertical groundwater inflow.

- Seep flow at SW097 is most sensitive to the hydraulic conductivity of the waste material and other unconsolidated material, the hydraulic conductivity of the LD drainage material, and the hydraulic conductivity of the weathered bedrock. Modeling results show subsurface water in the footprint of the landfill system, upgradient of the seep, discharging to the seep or pond, regardless of whether the Landfill Trench System is functional.

- In a hypothetical scenario where additional cover material and fully developed vegetation are assumed, modeled seep flow is reduced by approximately 10 percent compared to the baseline scenario (i.e., current landfill configuration and WY2000 climate). In a comparably wet year, seep flow increased by approximately 10 percent, while mean modeled groundwater elevations in the landfill increased by 0.1 m.

- In another hypothetical scenario where recharge within the LCB and slurry walls is reduced by approximately 90 percent, modeled seep flow is reduced by approximately 25 percent over a 2.5-year period. This is mostly from a decrease in saturated zone storage. Lateral subsurface flow into the landfill area is still small but increases as a result of increased gradients across the landfill trench. Mean modeled groundwater elevations in the landfill decreased by 0.5 m.

10.0 REFERENCES

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Table 3-1. Saturated Hydraulic Conductivity Values

Saturated Material	K range from OU7 Phase I	K Geometric Mean OU7 Phase I	K Geometric Mean SWWB	Other Sources
Rocky Flat Alluvium (QRF)	3.37×10^{-4} to 2.99×10^{-5}	1.59×10^{-4}	2.1×10^{-4}	1E-03 to 1E-05 (2)
Weathered Bedrock KaKl(w)	1.29×10^{-6} to 1.48×10^{-7}	4.37×10^{-7}	n/a	
KaKlslt(w)	n/a	n/a	2.88E-05	
KaKlclst(w)	n/a	n/a	8.82E-07	
Unweathered Bedrock KaKlss(u)	4.73×10^{-7} to 5.92×10^{-7}	5.41×10^{-7}	5.77E-07	
KaKlslt(u)	n/a	n/a	1.59E-07	
KaKlclst(u)	n/a	n/a	2.48E-07	
Disturbed Alluvium & Fill Material (af)	6.20×10^{-5} to 5.90×10^{-6}	1.91×10^{-5}	n/a	
Landfill Debris (af)	1.35×10^{-4} to 2.32×10^{-5}	3.74×10^{-5}	n/a	2E-02 to 1.5E-04(3)
Qvf	n/a	n/a	2.54E-03	
QC	n/a	n/a	9.33E-05	
Gravel	n/a	n/a	n/a	0.1 to 100 (4)

Notes

1. Hydraulic conductivity values are posted in cm/sec
2. Value for silty sand from Freeze and Cherry (1979)
3. Range of values presented for Municipal Solid Waste (Qian, 2002)
4. Range for gravels from Freeze and Cherry (1979)

Key

KaKlss(w) = Undifferentiated Araphoe/Laramie weathered bedrock sandstones other than Araphoe No. 1 sandstones
KaKlslt(w) = Undifferentiated Arapahoe/Laramie weathered bedrock siltstones
KaKlclst(w) = Undifferentiated Arapahoe/Laramie weathered bedrock claystones
Qvf = Quaternary valley-fill alluvium
Qrf = Quaternary Rocky Flats Alluvium
Qc = Quaternary colluvium
KaKlss(u) = Undifferentiated Arapahoe/Laramie unweathered bedrock sandstones
KaKlslt(u) = Undifferentiated Arapahoe/Laramie unweathered bedrock siltstones
KaKlclst(u) = Undifferentiated Arapahoe/Laramie unweathered bedrock claystones

Table 7-1. Calibration Well Residuals

Well	Cnt. Of Rslts	Start Date	End Date	DTW (m) Average	Min	Max	Completion Unit	Modeled	Measured - Modeled
00393	20	1/4/94	12/2/94	2.75	1.74	3.11	ALLUVIUM	3.76	-1.01
00493	8	1/4/94	12/2/94	3.97	3.34	4.15	ALLUVIUM	3.19	0.77
0786	11	1/4/94	10/3/94	1.78	1.37	2.31	ALLUVIUM	0.67	1.12
1086	20	1/4/94	10/14/94	4.02	1.95	7.84	ALLUVIUM	4.38	-0.37
4087	11	6/2/94	10/3/94	2.28	1.65	2.53	ALLUVIUM	0.69	1.60
4287	10	1/4/94	6/6/94	1.20	1.01	1.68	ALLUVIUM	1.23	-0.03
5887	12	1/4/94	10/14/94	3.95	3.44	4.44	ALLUVIUM	4.79	-0.84
6087	14	1/4/94	10/13/94	3.90	2.66	4.32	ALLUVIUM	4.34	-0.44
6187	14	1/4/94	10/12/94	3.97	3.18	4.28	ALLUVIUM	4.68	-0.70
6287	6	1/4/94	10/10/94	4.38	4.15	4.54	ALLUVIUM	4.83	-0.45
6374	9	4/6/94	12/1/94	4.47	4.24	4.60	ALLUVIUM/BEDROCK	3.98	0.49
6387	4	01/26/93	06/07/93	4.72	4.72	4.72	ALLUVIUM	6.92	-2.20
6474	2	12/15/93	12/16/93	6.43	6.43	6.43	ALLUVIUM/BEDROCK	5.50	0.94
6487	19	1/4/94	11/2/94	6.59	6.50	6.63	ALLUVIUM	5.58	1.01
6574	2	12/15/93	12/16/93	4.24	4.24	4.24	ALLUVIUM/BEDROCK	3.85	0.39
6587	12	1/4/94	10/14/94	4.27	3.44	4.68	ALLUVIUM	7.36	-3.08
6674	1	5/3/94	5/3/94	2.71	2.71	2.71	ALLUVIUM/BEDROCK	2.22	0.49
6687	12	1/4/94	10/14/94	3.86	2.95	4.32	ALLUVIUM	4.84	-0.98
6787	10	01/13/93	07/06/93	3.32	2.69	3.56	ALLUVIUM	3.76	-0.44
6887	11	1/4/94	10/18/94	3.04	2.47	3.32	ALLUVIUM	3.83	-0.78
7087	19	1/4/94	11/1/94	3.53	1.96	5.44	ALLUVIUM/BEDROCK	3.82	-0.29
7187	12	1/4/94	10/13/94	2.47	1.82	2.90	ALLUVIUM	3.24	-0.77
7287	12	1/4/94	10/18/94	2.00	1.35	2.62	ALLUVIUM	2.21	-0.21
70093	15	1/4/94	12/2/94	4.39	3.56	4.74	ALLUVIUM	4.55	-0.16
70393	15	1/4/94	12/2/94	3.69	2.44	4.30	ALLUVIUM	4.01	-0.32
70693	15	1/4/94	12/2/94	5.55	4.08	6.32	ALLUVIUM	5.22	0.34
71193	13	1/4/94	12/2/94	4.15	3.31	4.55	ALLUVIUM	5.48	-1.33
71493	13	1/4/94	12/2/94	6.82	6.68	6.98	ALLUVIUM	5.52	1.30
71693	13	1/14/94	12/2/94	8.41	6.13	8.99	ALLUVIUM	6.96	1.45
71893	13	1/4/94	12/2/94	5.32	3.75	5.96	ALLUVIUM	7.14	-1.82
72093	13	1/4/94	12/2/94	7.64	6.77	9.37	ALLUVIUM	6.43	1.21
72293	13	1/4/94	12/2/94	9.89	9.78	9.92	ALLUVIUM	8.89	1.01
72393	13	1/4/94	12/2/94	7.39	6.53	9.21	ALLUVIUM	6.49	0.90
76792	7	1/4/94	12/2/94	2.57	1.90	2.93	ALLUVIUM	2.05	0.52
76992	9	1/4/94	10/10/94	3.65	2.83	4.35	ALLUVIUM	3.72	-0.06
77192	7	1/11/94	12/2/94	2.40	2.00	2.79	ALLUVIUM	1.11	1.30
77392	7	01/20/93	5/20/93	3.11	3.09	3.18	ALLUVIUM	3.97	-0.86
308-P-1	9	8/1/94	12/6/94	7.98	7.88	8.04	ALLUVIUM/BEDROCK	5.39	2.58
308-P-2	9	8/1/94	12/6/94	9.14	8.93	9.42	ALLUVIUM/BEDROCK	7.55	1.59
B106089	20	1/4/94	12/2/94	7.01	6.28	7.86	ALLUVIUM	6.57	0.44
B206389	10	01/13/93	07/12/93	3.57	3.49	3.65	ALLUVIUM	3.19	0.37
B206489	12	1/4/94	10/13/94	2.28	1.38	2.99	ALLUVIUM/BEDROCK	2.14	0.14
B208789	12	1/3/94	12/1/94	2.17	0.99	2.83	ALLUVIUM	1.91	0.26
00597	32	8-Oct-97	3-Oct-02	3.78	1.63	0.00	ALLUVIUM/BEDROCK	4.87	-1.09
1097	19	25-Sep-9	3-Oct-02	7.44	3.58	0.00	ALLUVIUM	6.40	1.04
1197	12	29-Sep-9	3-Apr-02	4.57	2.08	0.00	ALLUVIUM	5.29	-0.72
1297	11	25-Sep-9	4-Apr-02	4.79	0.67	0.00	ALLUVIUM	4.07	0.72
1397	13	30-Sep-9	31-Jul-0	3.26	0.40	0.00	ALLUVIUM/BEDROCK	3.62	-0.36
1497	18	25-Sep-9	4-Oct-02	4.24	1.21	0.00	ALLUVIUM	3.97	0.27
1597	10	8-May-98	4-Apr-02	5.33	1.37	0.00	ALLUVIUM	3.68	1.65
1697	17	30-Sep-9	15-Oct-0	7.59	5.21	0.00	ALLUVIUM	5.57	2.01
1797	10	8-May-98	4-Apr-02	6.83	4.79	0.00	ALLUVIUM	4.22	2.60
1897	11	29-Sep-9	3-Apr-02	5.30	3.07	0.00	ALLUVIUM	4.14	1.17
1997	12	30-Sep-9	3-Apr-02	4.08	2.33	0.00	ALLUVIUM	3.16	0.92
2097	18	30-Sep-9	3-Oct-02	2.44	1.13	0.00	ALLUVIUM	2.52	-0.08
2197	31	3-Mar-98	3-Oct-02	3.60	1.09	0.00	ALLUVIUM	4.41	-0.81
3498	5	4-Mar-98	25-Jan-0	4.33	4.22	0.00	ALLUVIUM/BEDROCK	2.45	1.88
6674	2	9-Jun-97	16-Jun-9	3.02	2.99	0.00	ALLUVIUM/BEDROCK	2.22	0.80
30100	14	2-Oct-00	3-Oct-02	2.71	2.44	0.00	ALLUVIUM/BEDROCK	2.39	0.33
30300	8	2-Oct-00	3-Apr-02	2.44	2.01	0.00	ALLUVIUM/BEDROCK	2.88	-0.44
30400	8	2-Oct-00	3-Apr-02	6.77	4.97	0.00	ALLUVIUM/BEDROCK	5.75	1.02
30500	8	12-Oct-0	3-Apr-02	4.88	2.14	0.00	ALLUVIUM/BEDROCK	3.43	1.44
30800	9	12-Oct-0	3-Apr-02	1.98	1.61	0.00	ALLUVIUM/BEDROCK	2.18	-0.20
30900	26	2-Oct-00	2-Oct-02	3.81	1.43	0.00	ALLUVIUM/BEDROCK	3.72	0.09
31001	24	30-Jan-0	1-Oct-02	3.44	1.11	0.00	ALLUVIUM/BEDROCK	3.71	-0.26
52894	46	7-Jan-97	11-Nov-0	2.04	1.00	0.00	ALLUVIUM	0.80	1.25
61495	20	9-Jan-97	3-Oct-02	1.92	0.89	0.00	ALLUVIUM	3.88	-1.96
61595	20	9-Jan-97	3-Oct-02	1.25	0.28	0.00	ALLUVIUM	2.33	-1.08
61695	20	9-Jan-97	3-Oct-02	1.34	0.48	0.00	ALLUVIUM	3.10	-1.76
70099	52	6-Oct-99	18-Oct-0	6.22	5.14	0.00	ALLUVIUM/BEDROCK	3.28	2.94

Notes:
Average values for wells 72093 and 72393 were adjusted to account for surface change during 1994.

Table 7-2. Validation Well Residuals

Well	Cnt. Of Rslts	Start Date	End Date	DTW (m)			Completion Unit	Modeled	Measured Modeled
				Average	Min	Max			
4087	17	10/5/1999	9/5/2000	1.65	0.96	2.45	ALLUVIUM	0.46	1.19
5887	9	10/5/1999	9/21/2000	3.54	2.60	4.21	ALLUVIUM	4.52	-0.98
6087	2	10/5/1999	4/12/2000	3.07	2.69	3.45	ALLUVIUM	3.94	-0.87
7187	2	10/5/1999	4/12/2000	2.07	1.86	2.27	ALLUVIUM	2.97	-0.91
B208789	7	10/6/1999	7/6/2000	1.84	0.92	3.83	ALLUVIUM	0.91	0.93
P114389	17	10/6/1999	9/8/2000	2.24	1.97	2.42	ALLUVIUM	2.14	0.10
76792	2	10/5/1999	4/11/2000	2.11	2.11	2.11	ALLUVIUM	1.96	0.15
76992	6	10/5/1999	7/26/2000	3.72	3.66	3.78	ALLUVIUM	3.45	0.27
77392	6	10/6/1999	7/5/2000	3.09	3.08	3.10	ALLUVIUM	3.65	-0.56
70393	11	10/5/1999	9/22/2000	3.54	2.88	4.21	ALLUVIUM	3.47	0.08
70693	2	10/5/1999	4/12/2000	4.57	4.16	4.98	ALLUVIUM	4.81	-0.24
308-P-1	1	4/17/2000	4/17/2000	7.39	7.39	7.39	ALLUVIUM/BEDROCK	5.44	1.95
308-P-2	4	12/2/1999	4/17/2000	8.34	8.23	8.48	ALLUVIUM/BEDROCK	7.46	0.88
52894	7	10/5/1999	9/25/2000	1.84	1.43	2.15	ALLUVIUM	0.69	1.16
61495	2	10/5/1999	4/11/2000	1.60	1.35	1.84	ALLUVIUM	3.72	-2.12
61595	1	4/11/2000	4/11/2000	0.65	0.65	0.65	ALLUVIUM	1.95	-1.30
61695	2	10/5/1999	4/11/2000	1.13	1.02	1.23	ALLUVIUM	2.69	-1.56
597	6	10/6/1999	9/22/2000	3.60	2.72	3.98	ALLUVIUM/BEDROCK	4.43	-0.83
1097	3	4/25/2000	9/18/2000	7.40	7.11	7.54	ALLUVIUM	6.11	1.29
1197	2	4/25/2000	9/19/2000	4.47	3.79	5.14	ALLUVIUM	4.84	-0.37
1297	2	4/25/2000	9/19/2000	8.10	4.55	11.65	ALLUVIUM	3.54	4.56
1397	2	4/25/2000	9/20/2000	3.20	2.53	3.88	ALLUVIUM/BEDROCK	3.12	0.08
1497	2	4/25/2000	9/20/2000	4.04	3.36	4.71	ALLUVIUM	3.45	0.59
1597	2	4/25/2000	9/19/2000	5.56	5.27	5.85	ALLUVIUM	3.22	2.34
1697	2	4/25/2000	9/19/2000	7.35	6.92	7.79	ALLUVIUM	5.19	2.17
1797	2	4/25/2000	9/19/2000	6.81	6.65	6.98	ALLUVIUM	3.75	3.06
1897	2	4/25/2000	9/20/2000	5.27	4.88	5.65	ALLUVIUM	3.65	1.62
1997	2	4/25/2000	9/20/2000	4.13	3.91	4.35	ALLUVIUM	2.86	1.27
2097	1	9/21/2000	9/21/2000	2.38	2.38	2.38	ALLUVIUM	2.29	0.09
2197	7	10/5/1999	7/6/2000	4.09	3.96	4.17	ALLUVIUM	4.09	0.00
3498	1	1/25/2000	1/25/2000	4.26	4.26	4.26	ALLUVIUM/BEDROCK	2.34	1.91

Table 7-3. Model Sensitivity Runs

Parameter	Catchment	Calibrated value		Sensitivity Range	
				Low	High
Waste saturated Kh/Kv (m/sec)	landfill	1.00E-05		1.00E-06	1.00E-04
Leachate Collection System (LCRS) Kh/Kv (m/sec)	landfill	1.00E-03		1.00E-04	1.00E-02
GW Intercept system (GWIS) leakance values (1/sec)	landfill	1.00E-04		1.00E-05	1.00E-03
Landfill clay barrier slurry wall leakance (1/sec)	landfill	1.00E-10		1.00E-12	1.00E-08
landfill slurry wall leakance (1/sec)	landfill and east	1.00E-10		1.00E-12	1.00E-08
(combine with dam slurry wall)					
dam slurry wall leakance (1/sec)		1.00E-10		1.00E-12	1.00E-08
(combine with landfill slurry wall)	landfill and east				
Kh external soils (layers 1 & 2) (m/sec)	full model			0.1x	2x
Kh/Kv underlying weathered bedrock (m/sec)	landfill and east	6.00E-08		6.00E-09	6.00E-07
Waste unsaturated Kh (m/sec)	landfill	1.00E-05		1.00E-06	1.00E-04
unsaturated Parameters of waste (available porosity)	landfill	0.228		0.15	0.4
Kh/Kv underlying unweathered bedrock (m/sec)	landfill and east	2.48E-09		2.48E-10	2.48E-08
Kh underlying waste (layer 2) (m/sec)	landfill	5.12E-06		5.12E-07	
Landfill Pond Set to 1994 max/min levels (m)	landfill pond and east			1802.95	1804.05

Model "What - if" scenarios

No GWIS	landfill				
No landfill Clay Barrrier	landfill				
GWIS drains to end of perforated pipe	landfill				
No landfill trench system components	full model				

Table 7-4. Model Sensitivity Results

Parameter	Catchment	Change	Value	Average Seep Flow	Average GWIS Drainage		Avg. Landfill Heads	Avg. Below Dam Heads
Waste saturated Kh/Kv (m/sec)	landfill	high	1.00E-04					n/a
		low	1.00E-06					n/a
Leachate Collection System (LCRS) Kh/Kv (m/sec)	landfill	high	1.00E-02					n/a
		low	1.00E-04					n/a
GW Intercept system (GWIS) leakance values (1/sec)	landfill	high	1.00E-03					n/a
		low	1.00E-05					n/a
Landfill clay barrier slurry wall leakance (1/sec)	landfill	high	1.00E-08					n/a
		low	1.00E-12					n/a
landfill slurry wall leakance (1/sec)	landfill and east	high	1.00E-08					n/a
(combine with dam slurry wall)		low	1.00E-12					n/a
dam slurry wall leakance (1/sec)	landfill and east	high	1.00E-08	n/a	n/a		n/a	
		low	1.00E-12	n/a	n/a		n/a	
Kh external soils (layers 1 & 2) (m/sec)	full model	high	2x					
		low	0.1 x					
Kh/Kv underlying weathered bedrock (m/sec)	landfill and east	high	6.00E-07					
		low	6.00E-09					
Waste unsaturated Kh (m/sec)	landfill	high	1.00E-04					n/a
		low	1.00E-06					n/a
unsaturated Parameters of waste (available porosity)	landfill	high	0.4					n/a
		low	0.15					n/a
Kh/Kv underlying unweathered bedrock (m/sec)	landfill and east	high	2.48E-08					
		low	2.48E-10					
Kh underlying waste (layer 2) (m/sec)	landfill	low	5.12E-07					n/a
Landfill Pond Set to 1994 max/min levels (m)	landfill pond and east	high	1804.05	n/a	n/a		n/a	
		low	1802.95	n/a	n/a		n/a	
Model "What - if" scenarios								
No GWIS	landfill							n/a
No landfill Clay Barrrier	landfill							n/a
GWIS drains to end of perforated pipe	landfill							n/a
No landfill trench system components	full model				n/a			n/a

Notes:
n/a - not applicable
green is a 10% or greater increase in flow rates or an increase in average heads of 0.1 m or greater
blue is a change of less than 10% in flow rates or 0.1 m in average heads
yellow is a 10% or greater decrease in flow rates or a drop in average heads of 0.1 m or greater

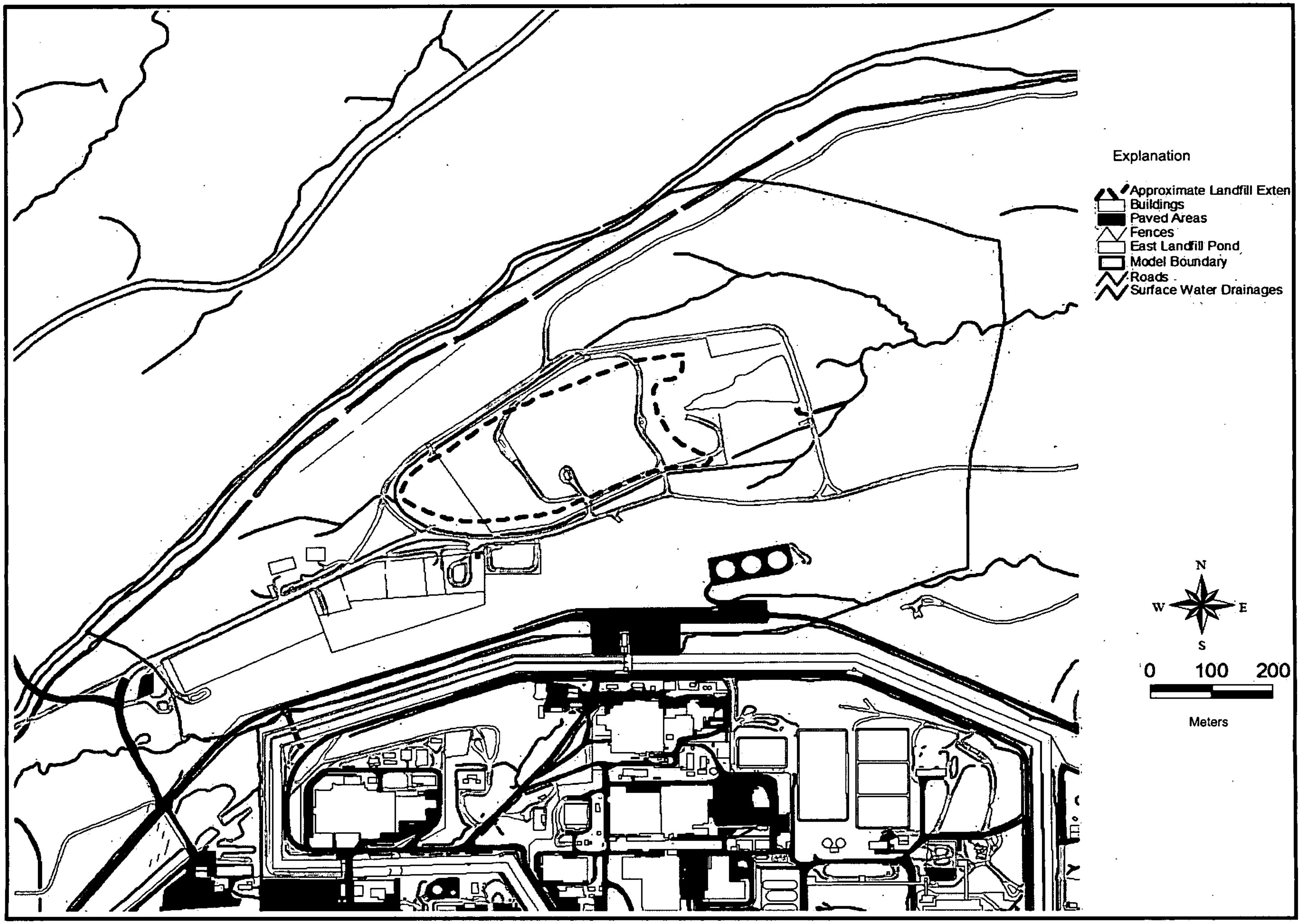


Figure 2-1. Present Landfill Study Area - Site Map

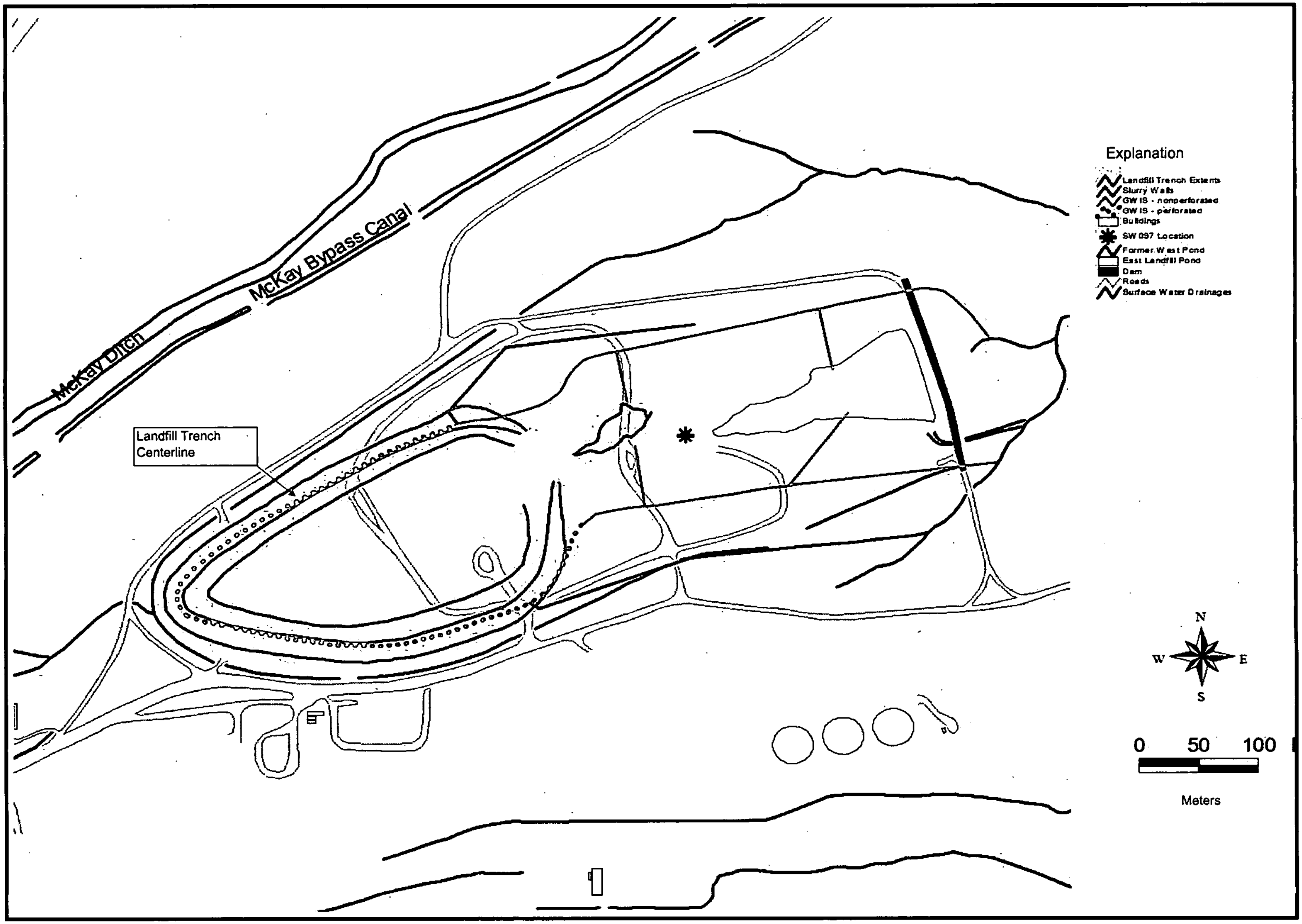
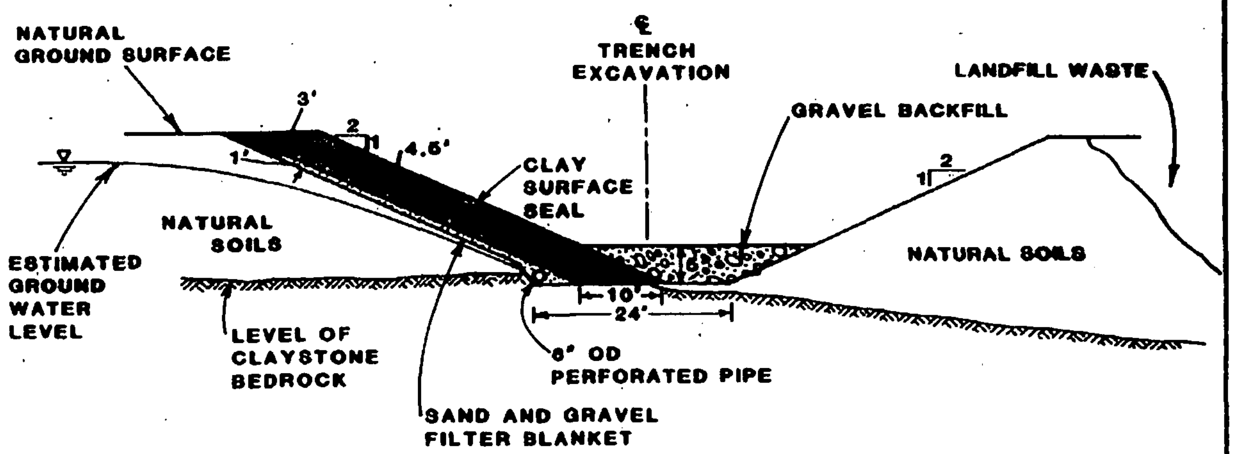


Figure 2-2. Present Landfill Features



SCALE 1"=20'

AS-BUILT SECTION

6 032 88	Chen & Associates	TYPICAL LEACHATE AND GROUND-WATER COLLECTION SYSTEM	Fig. 4

Figure 2-3. Generalized Landfill Trench System (Rockwell, 1988)

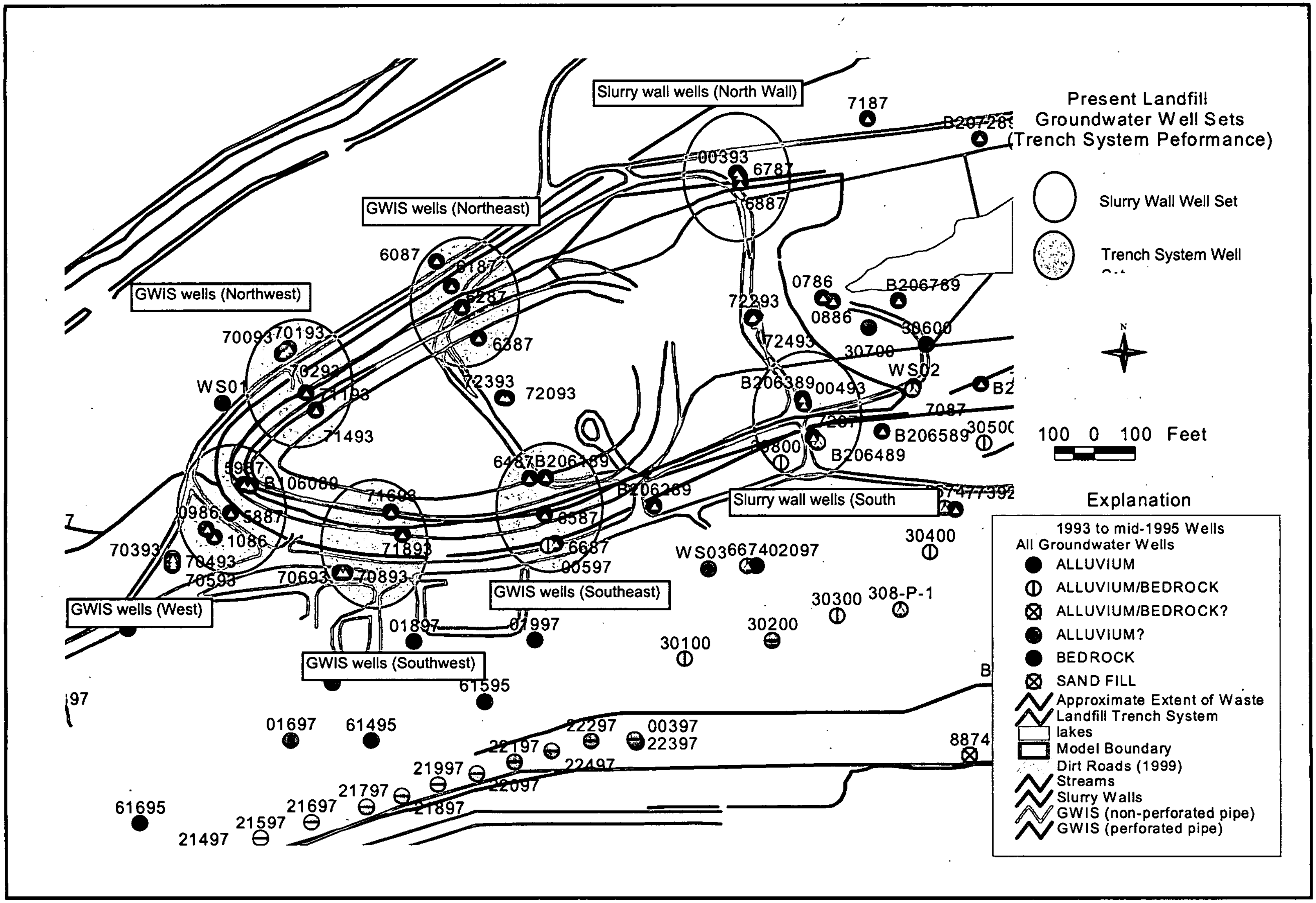


Figure 3-9. Trench System Groundwater Well Locations

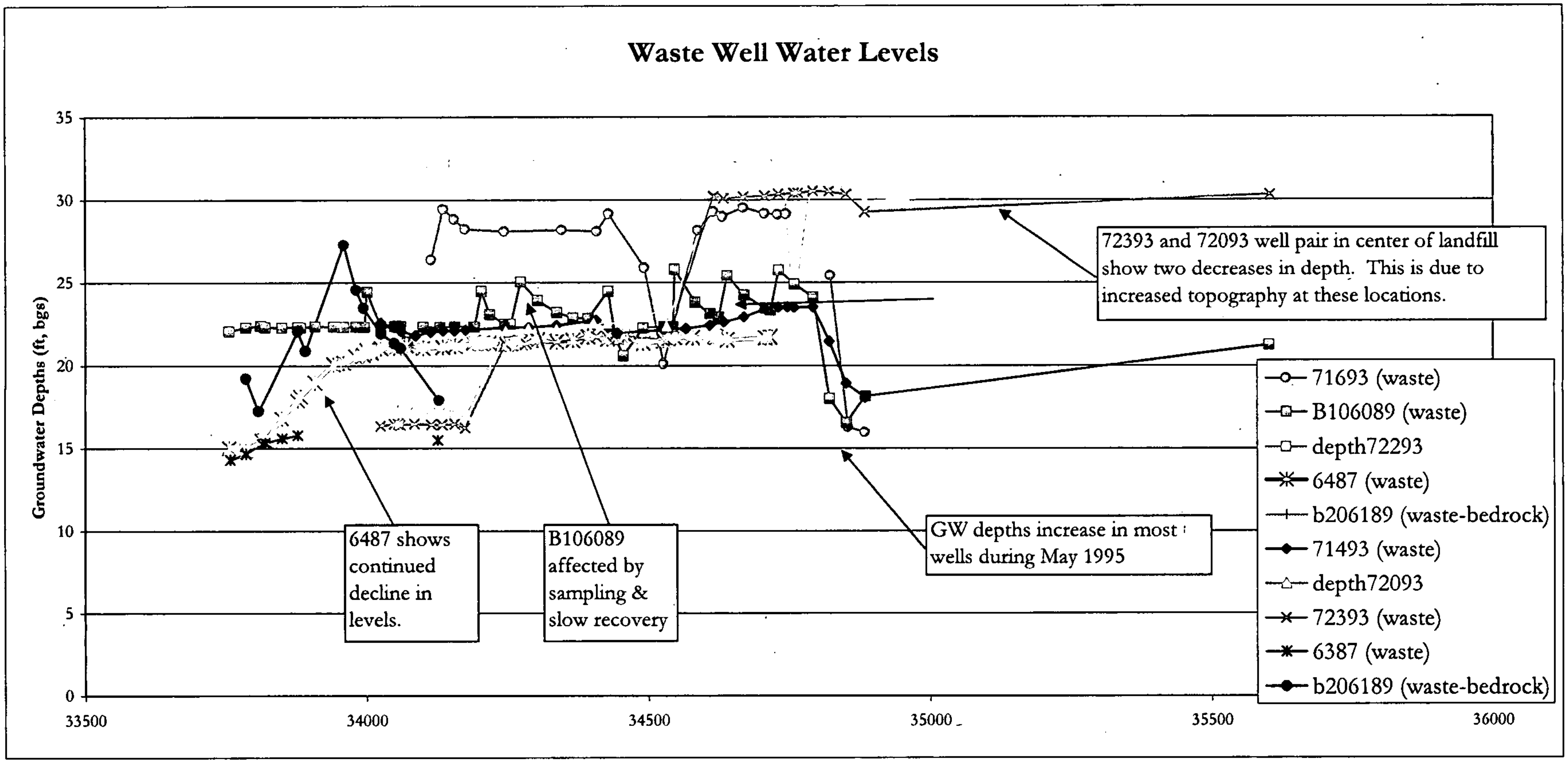
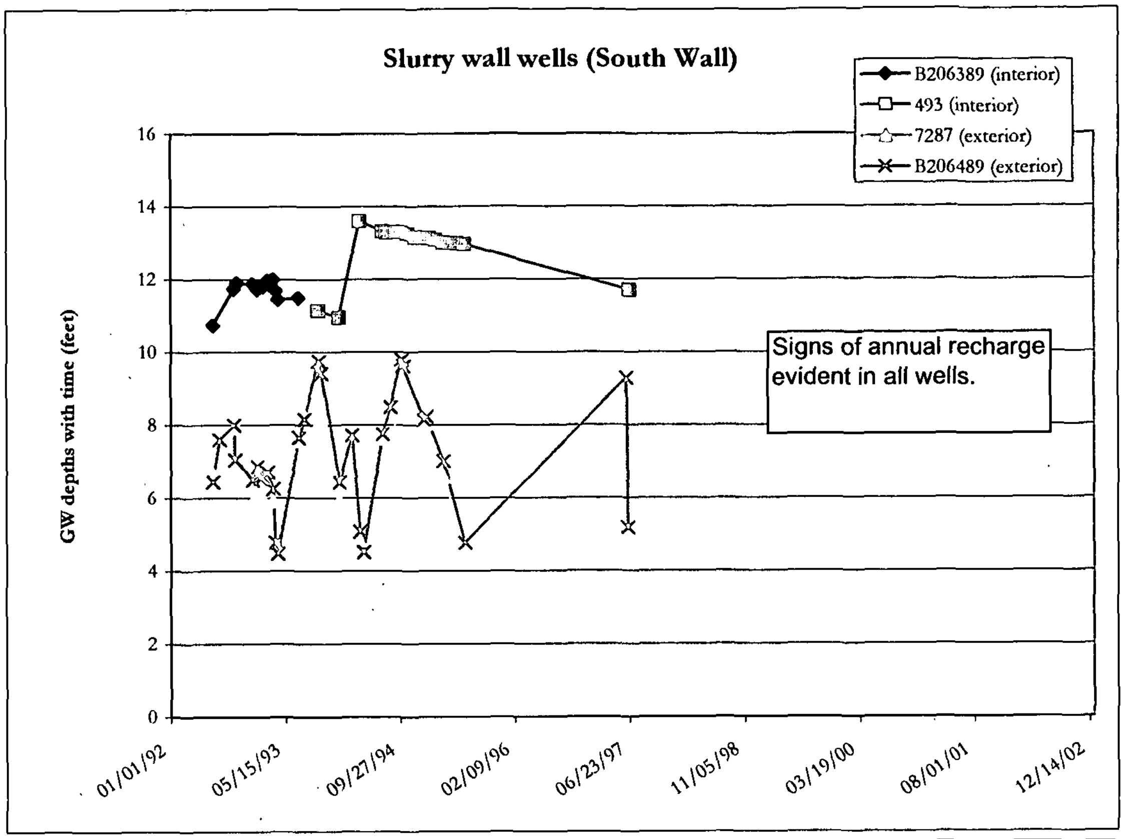


Figure 3-10. Waste Well Groundwater Response



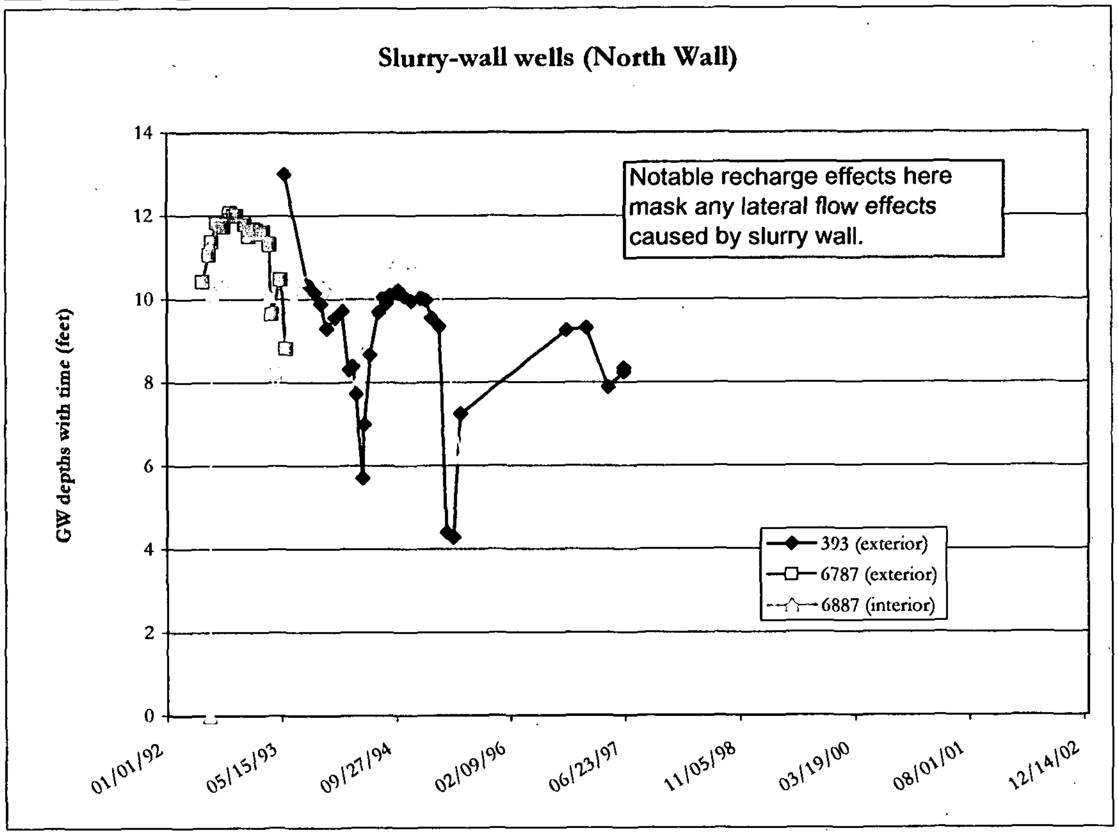
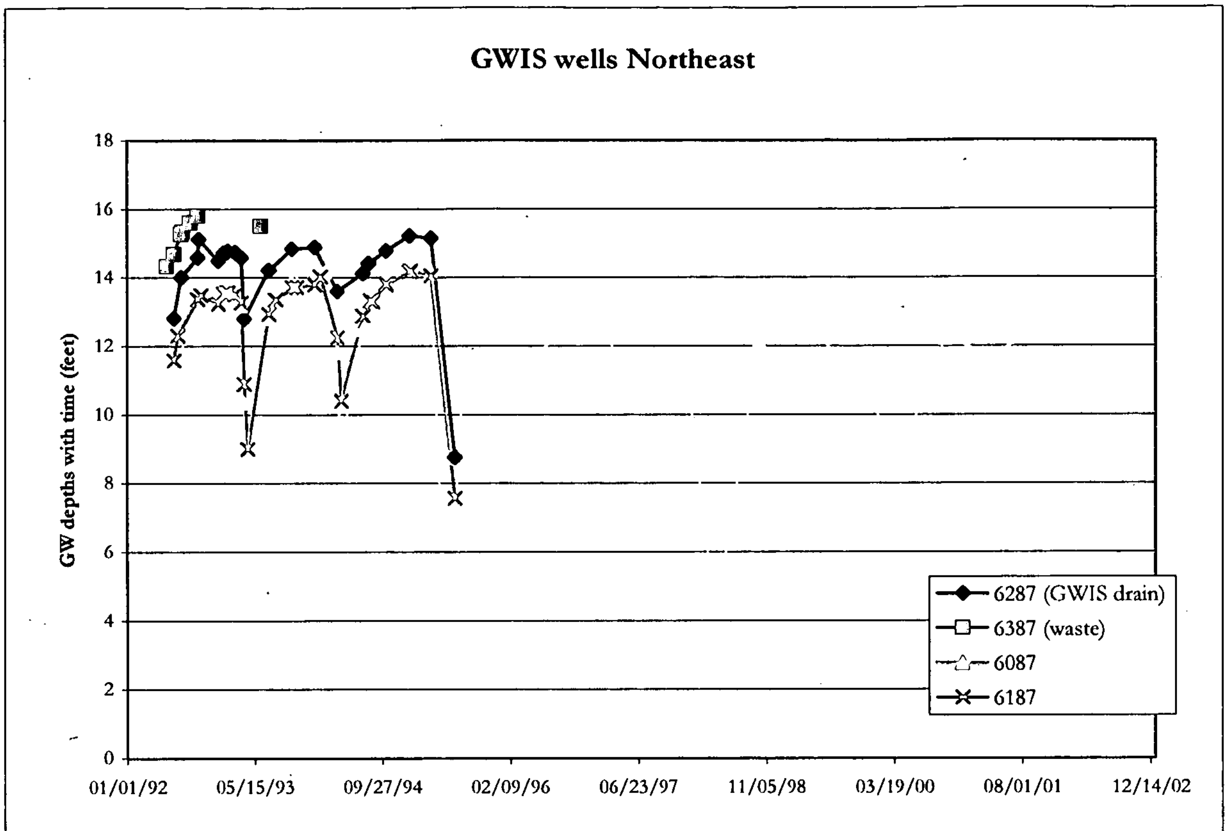


Figure 3-11. Slurry Wall Groundwater Well Response



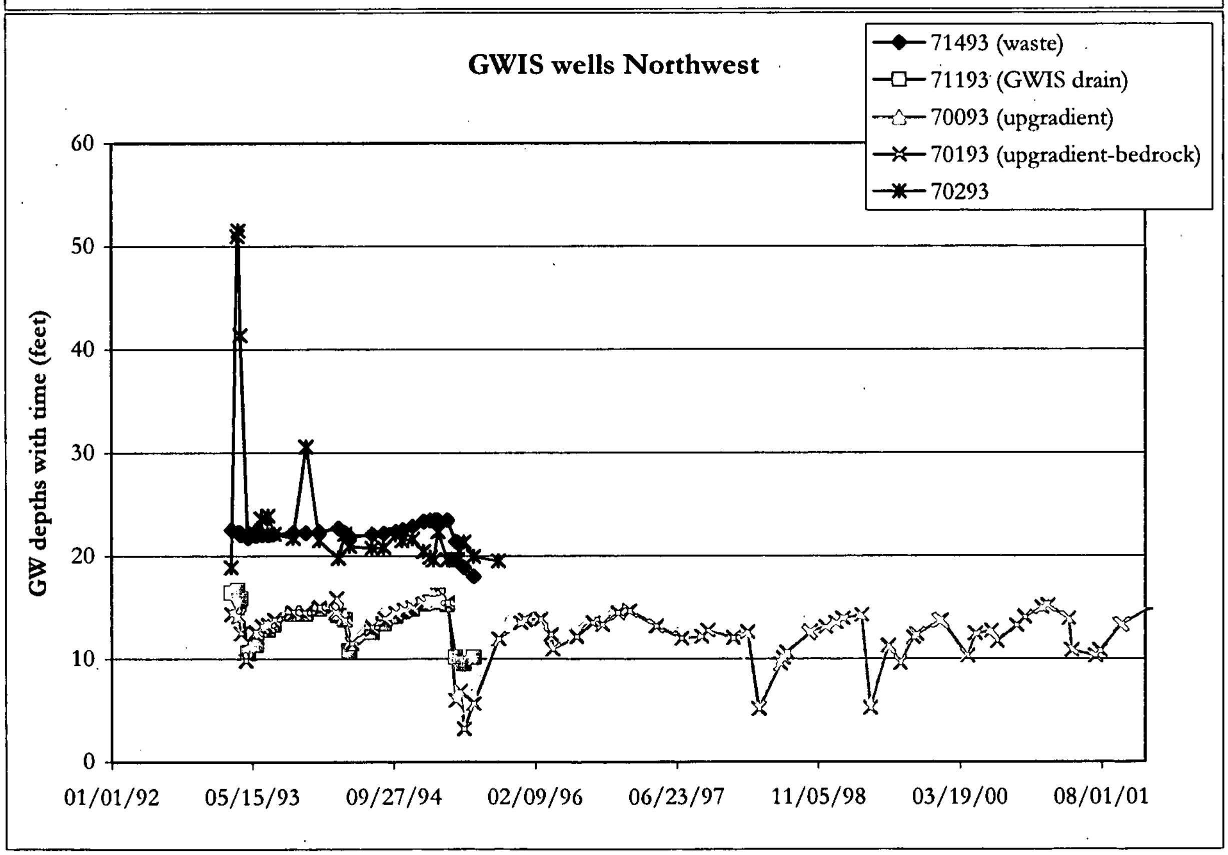


Figure 3-12. GWIS Groundwater Well Response (North)

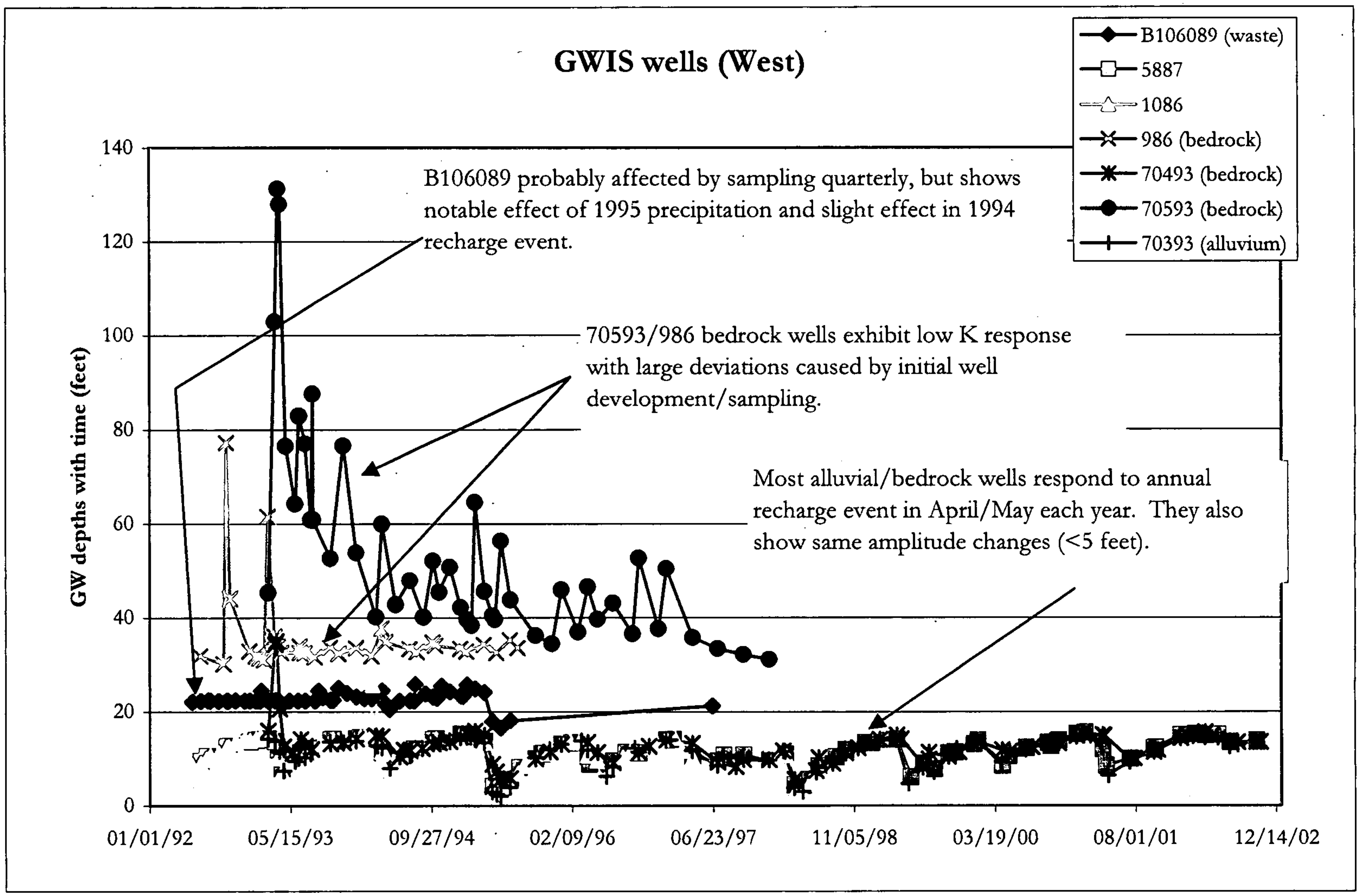
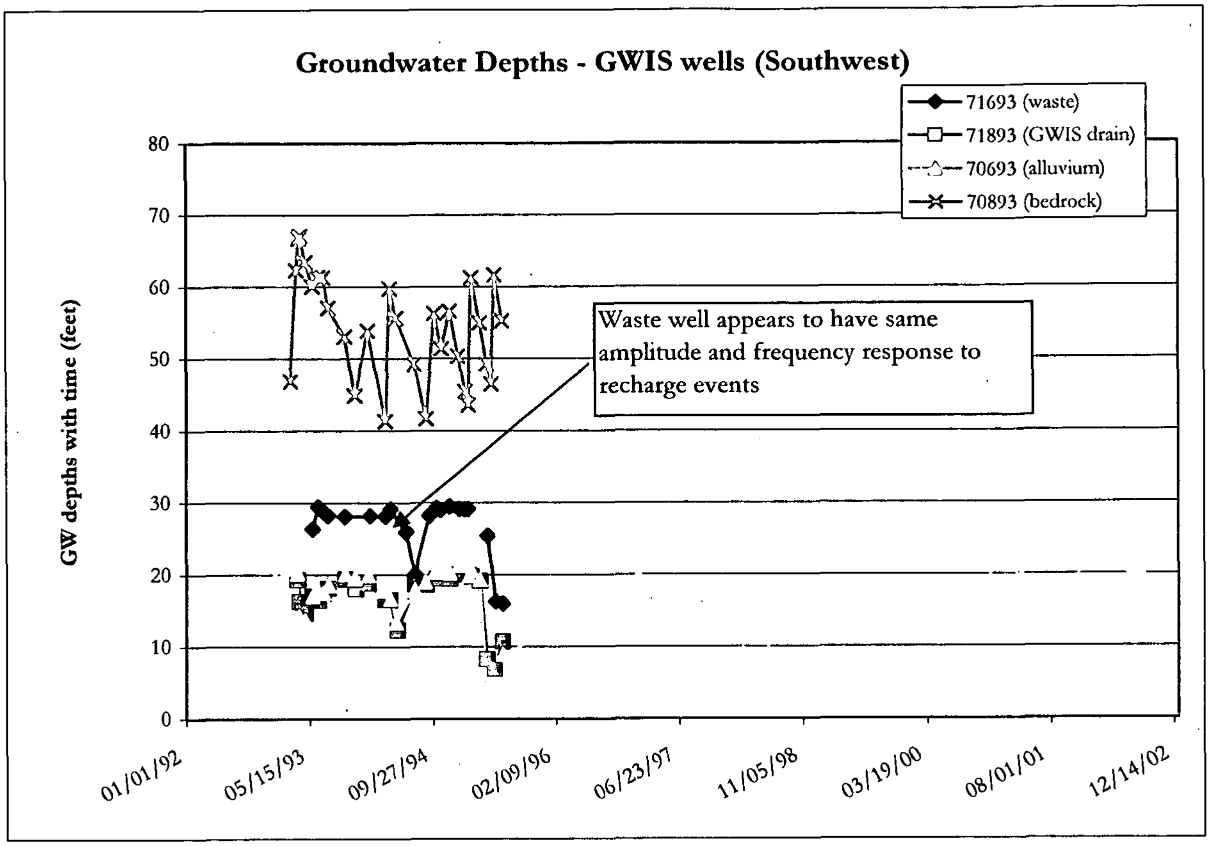


Figure 3-13. GWIS Wells Response (West)



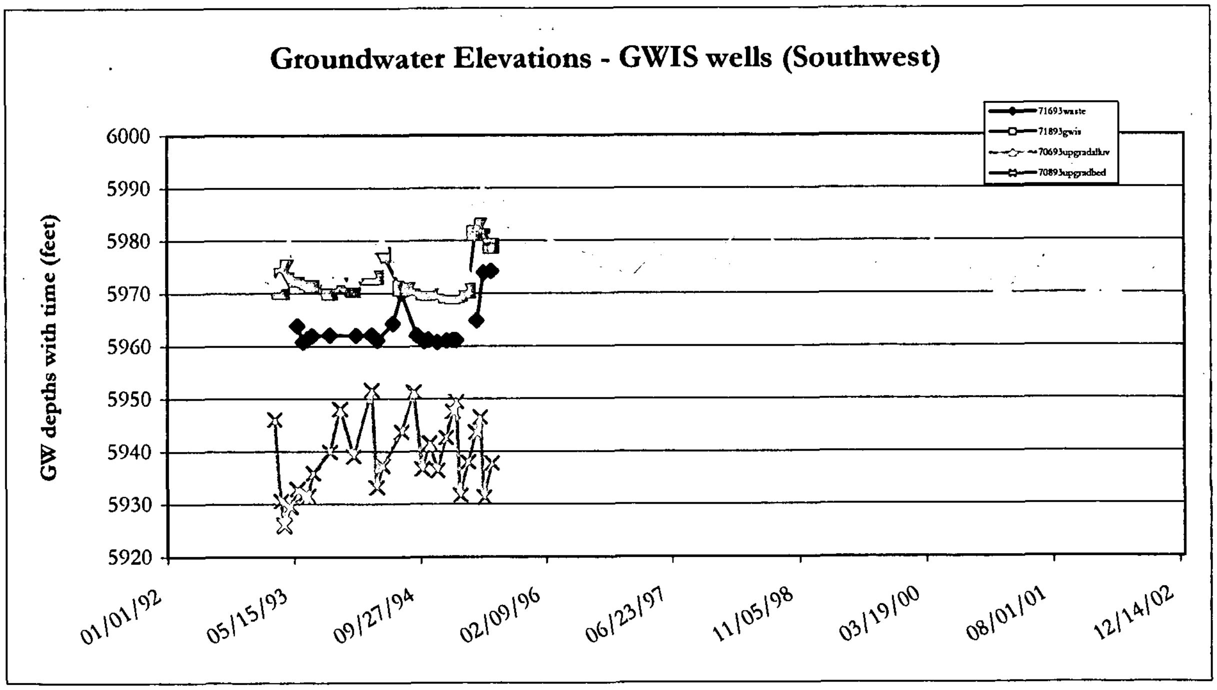


Figure 3-14. GWIS Well Response (Southwest)

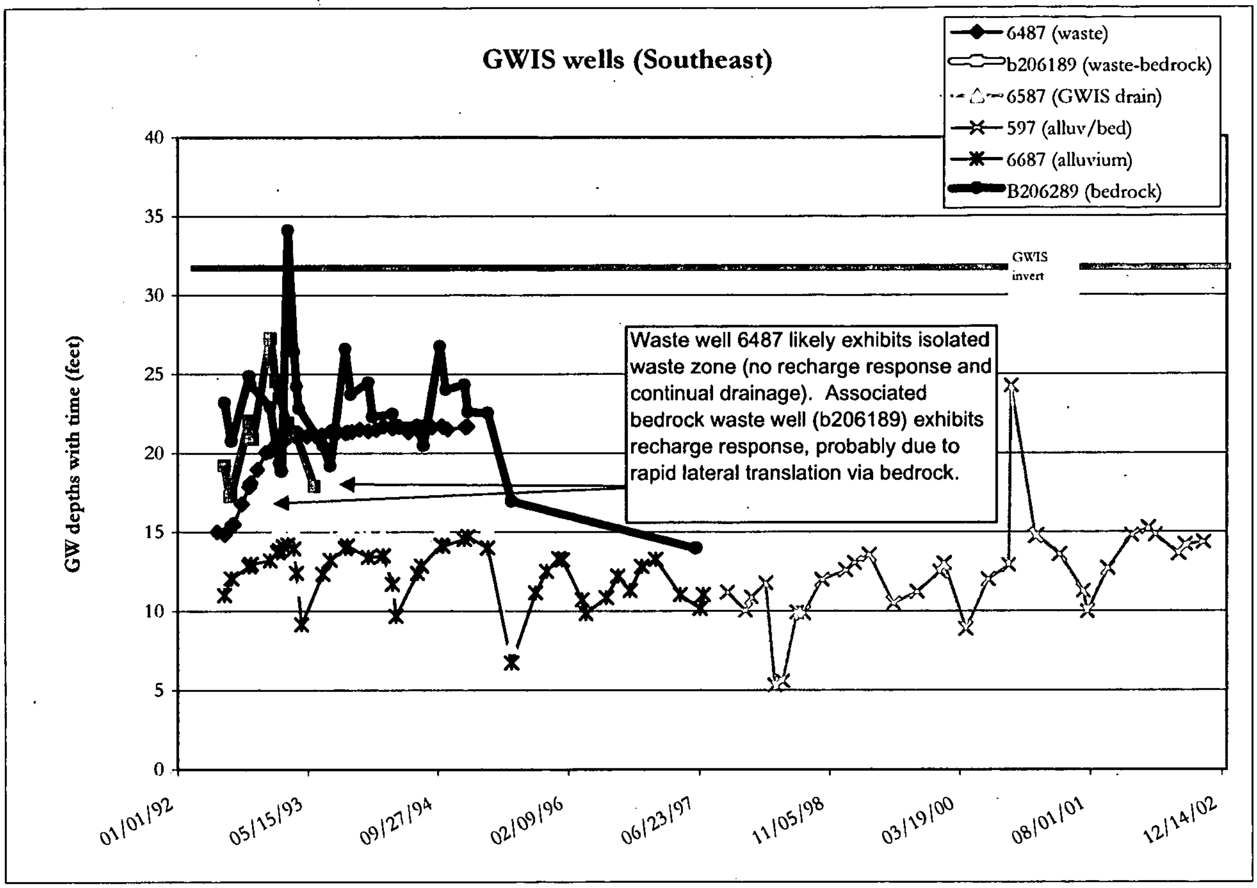


Figure 3-15. Groundwater Well Response GWIS (Southeast)

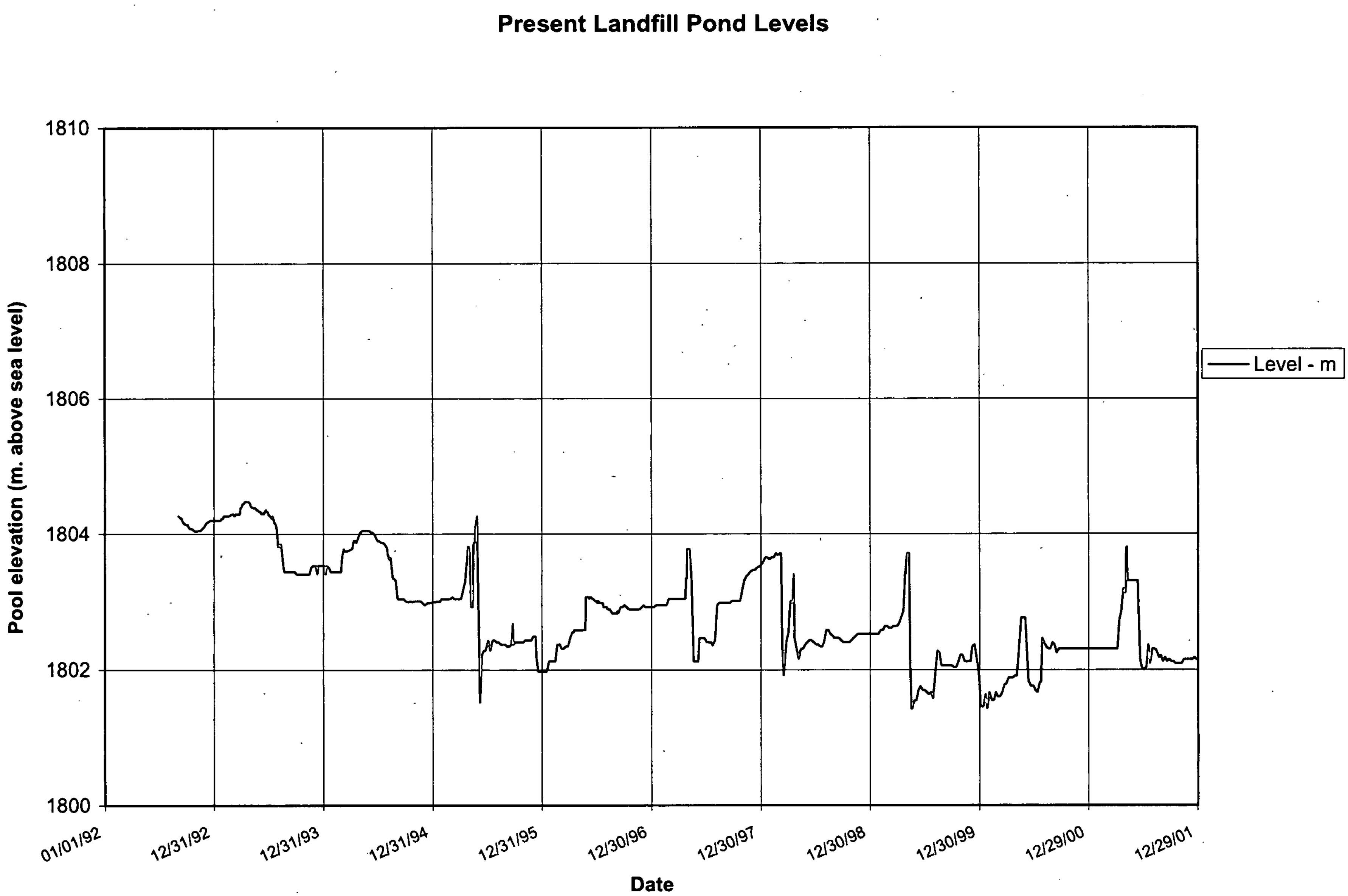
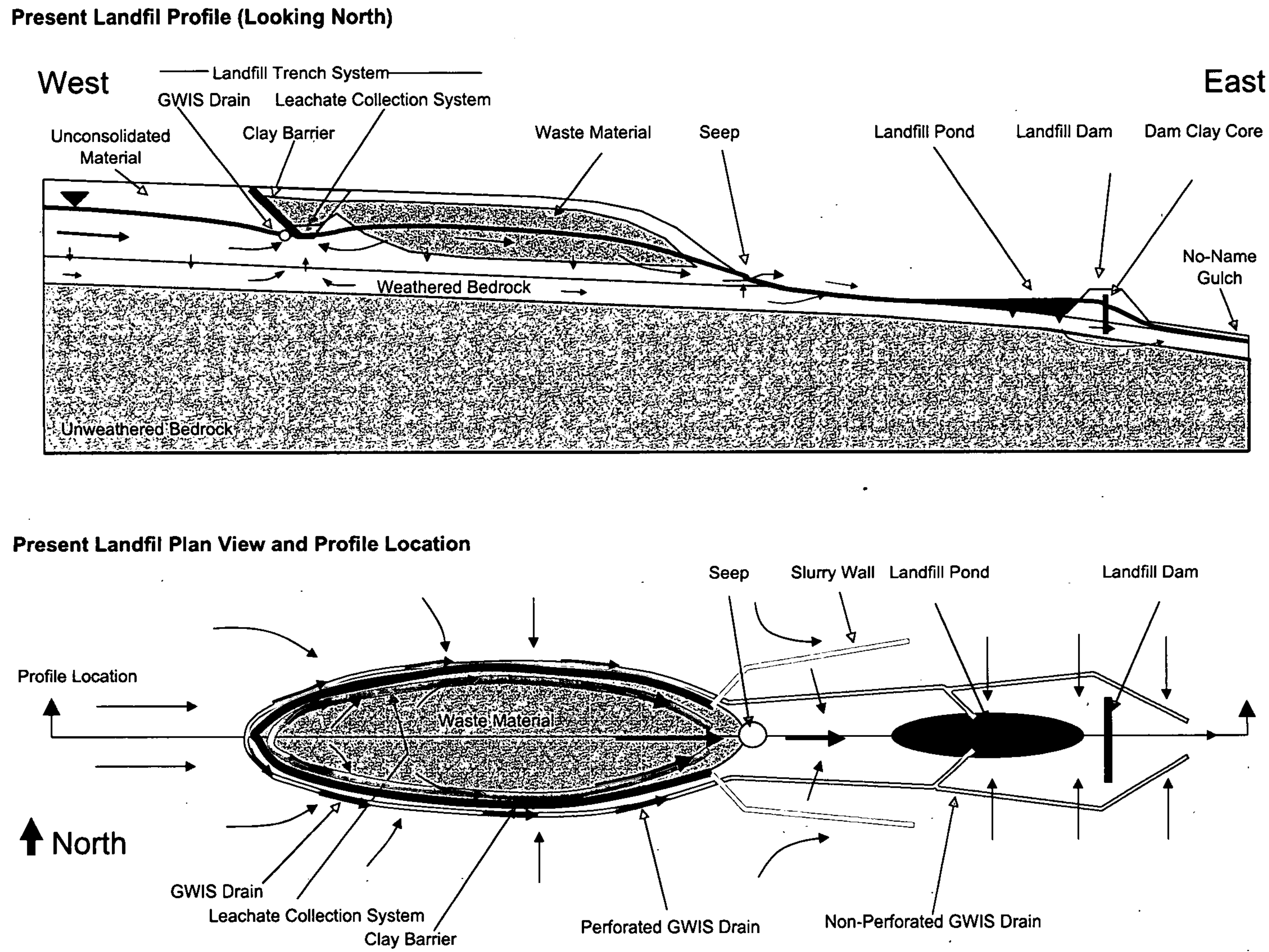


Figure 3-16. Present Landfill Pond Levels



Note: Flow arrows depict groundwater flow directions and are sized to approximate flow magnitudes

Figure 4-2. Present Landfill Conceptual Flow Model

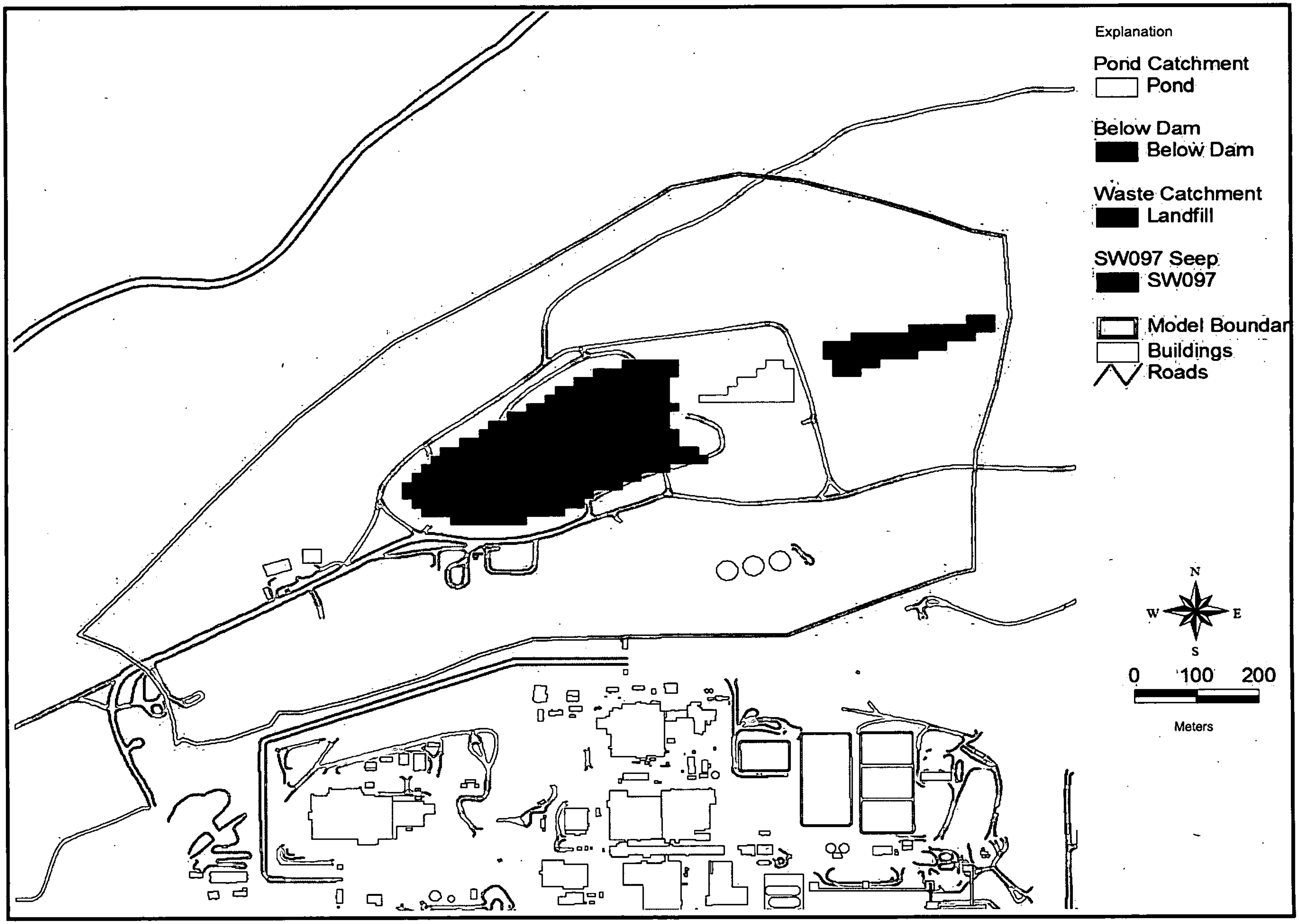


Figure 5-2. Model Focus Areas

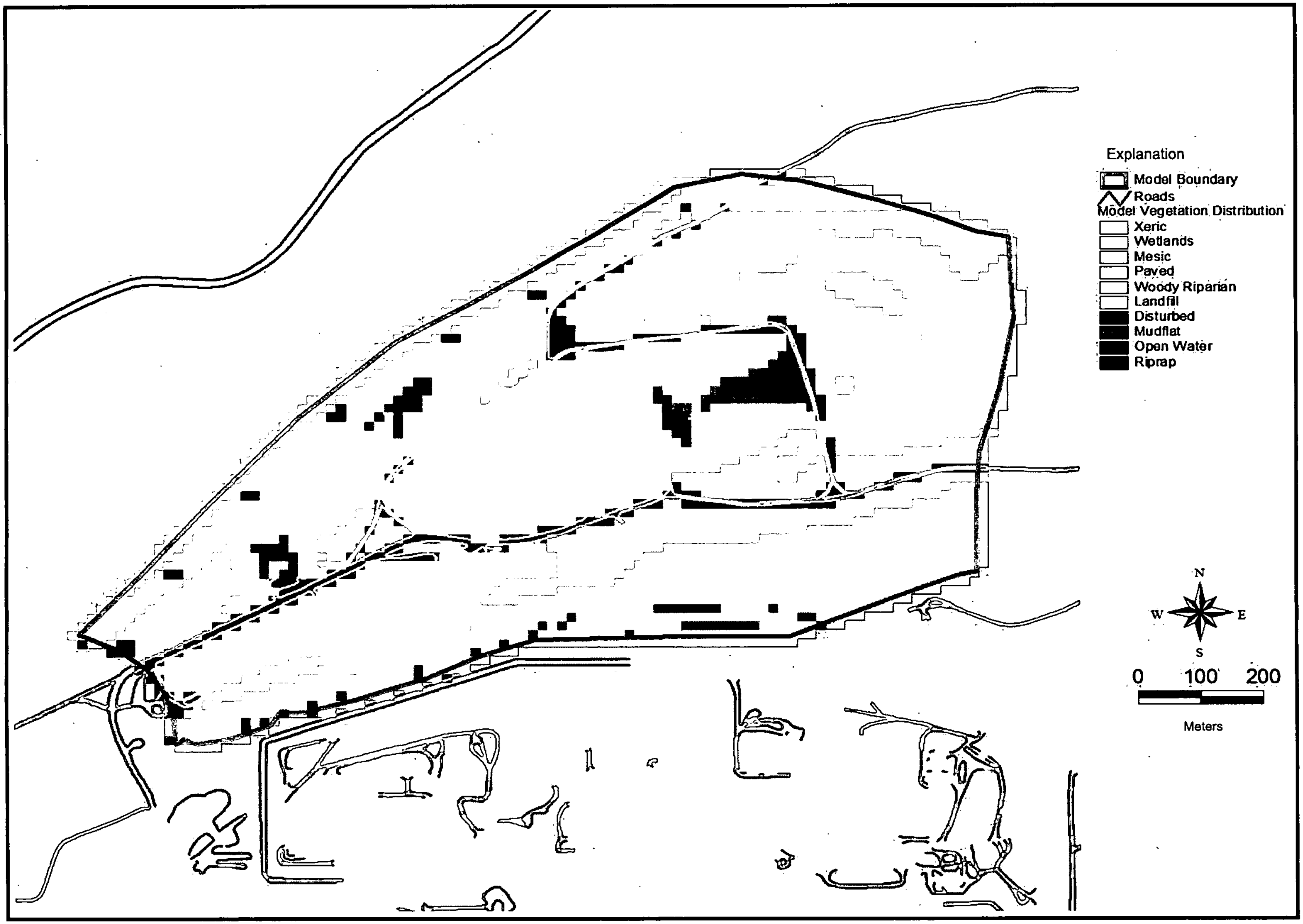


Figure 6-1. Model Vegetation Distribution

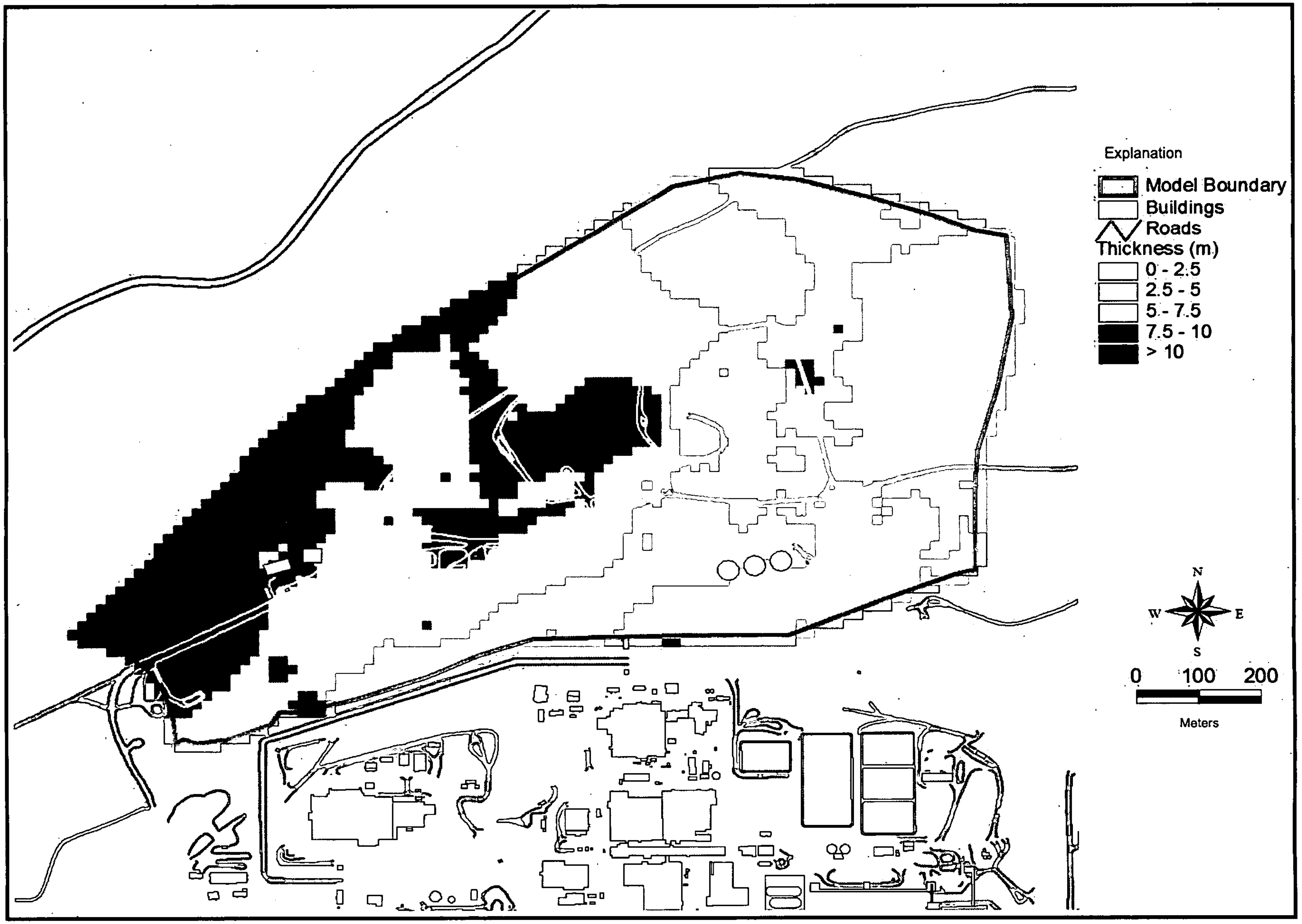


Figure 6-2. Model Unconsolidated Material Thickness

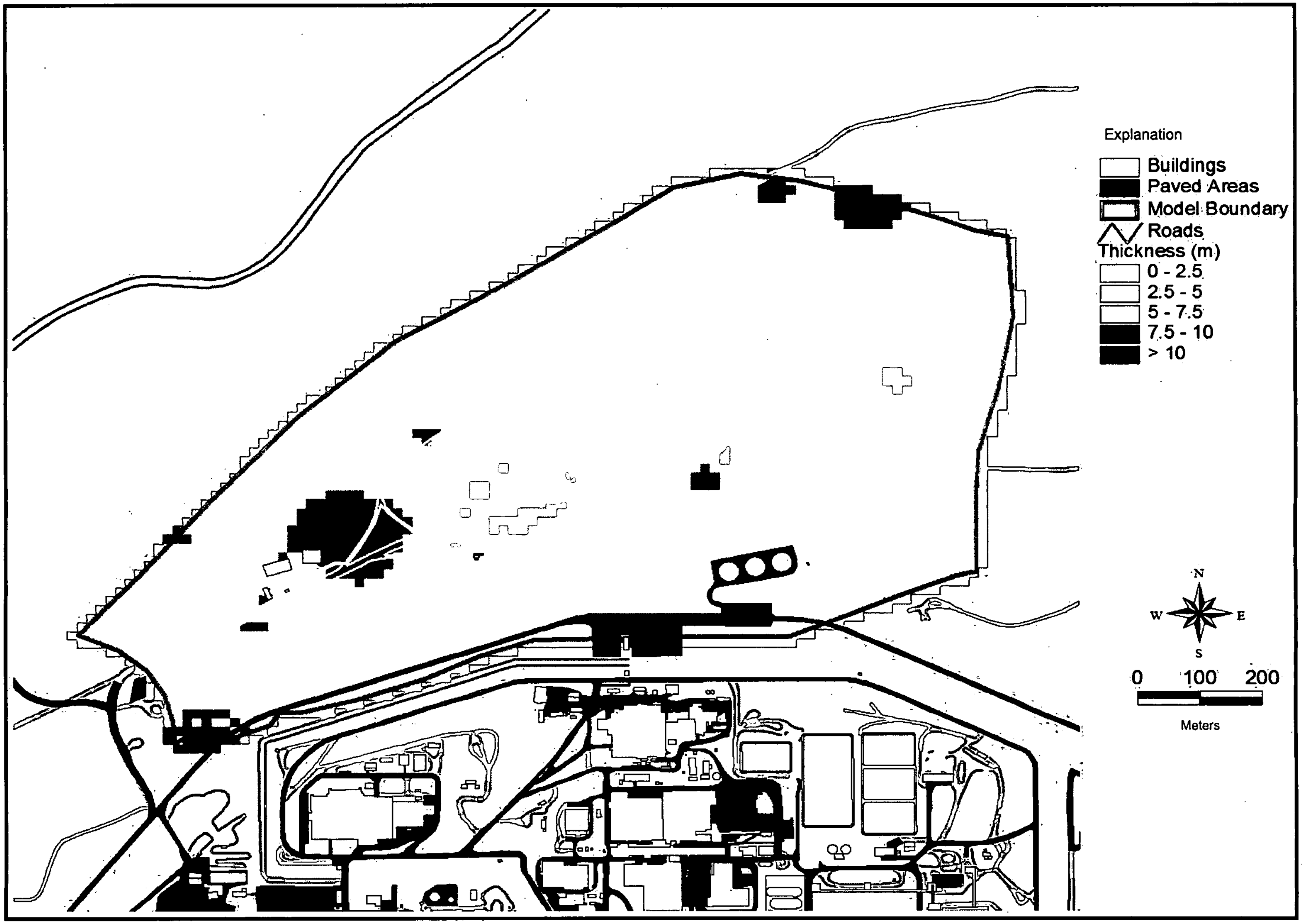


Figure 6-3. Model Weathered Bedrock Thickness

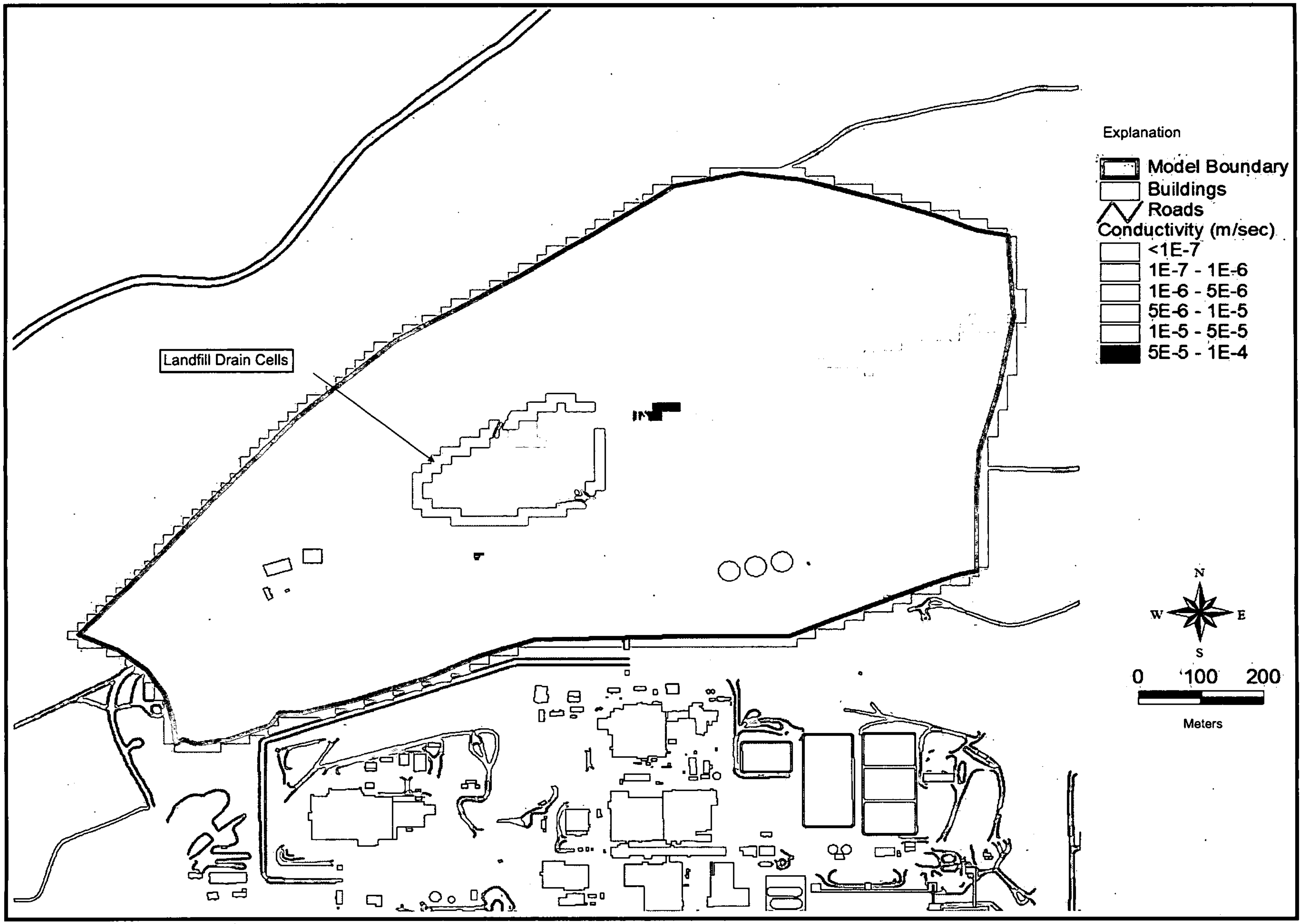


Figure 6-4. Model Layer 1 Hydraulic Conductivity Distribution

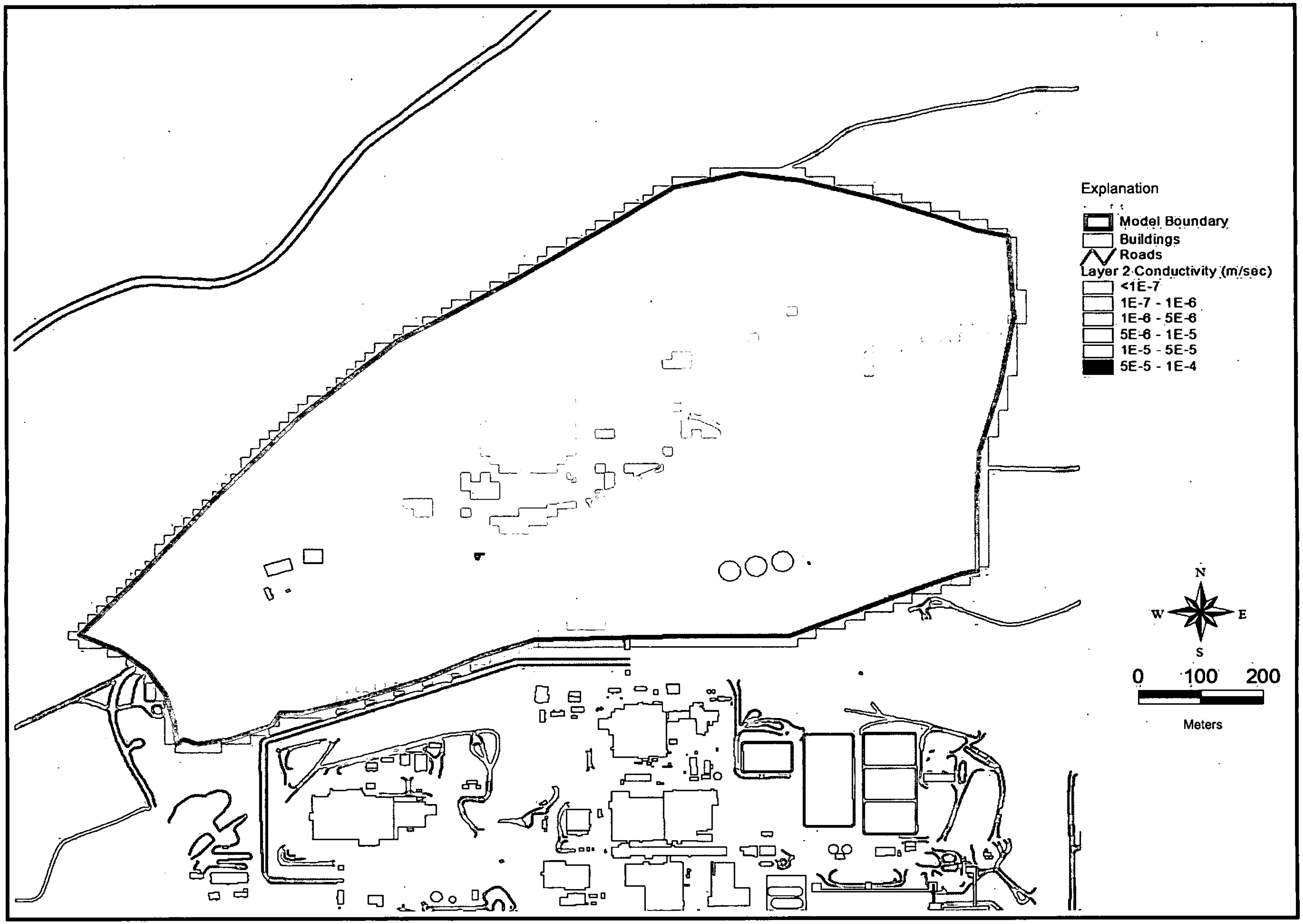


Figure 6-5. Model Layer 2 Hydraulic Conductivity Distribution

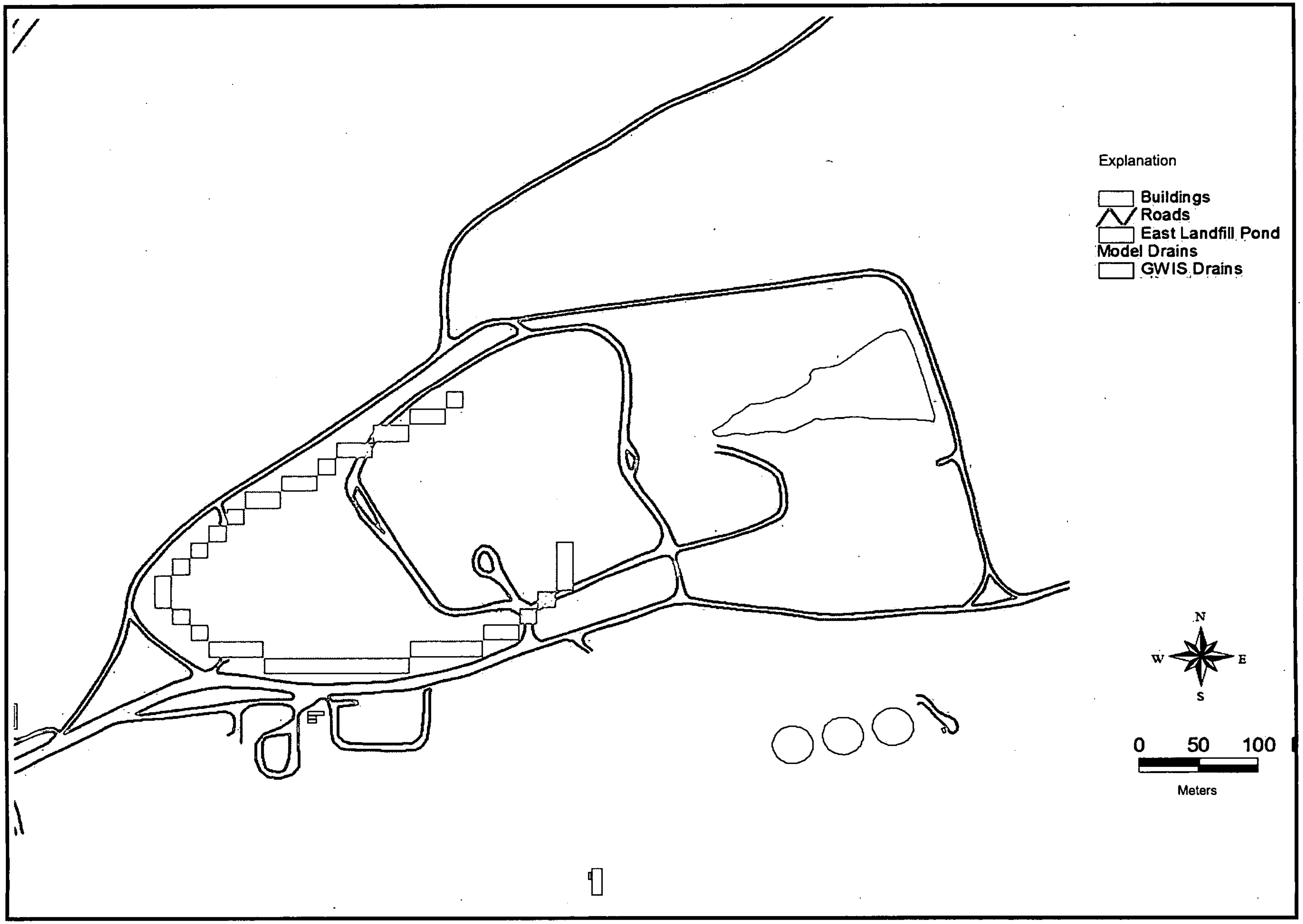


Figure 6-6. Model GWIS Drain Cell Locations

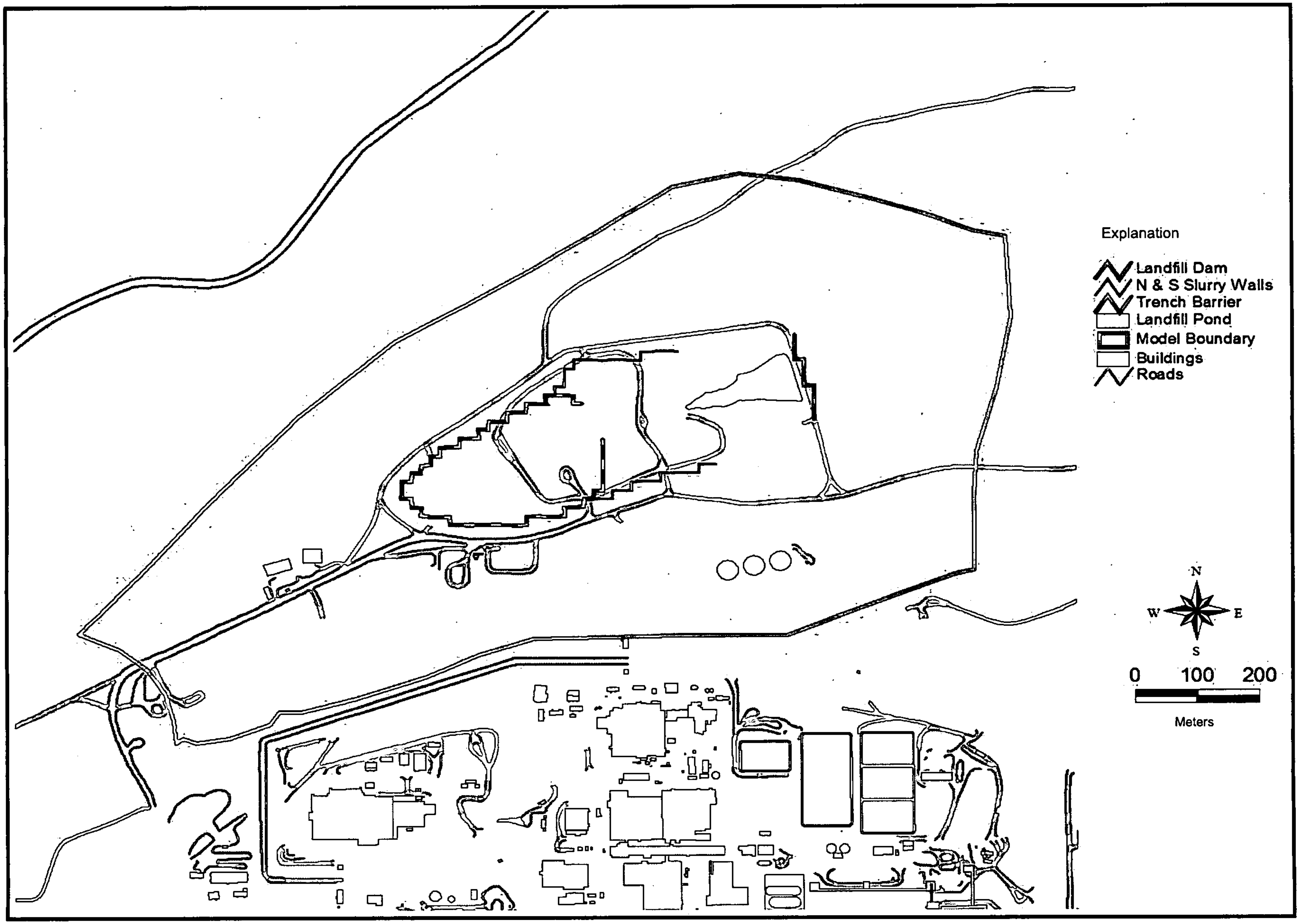


Figure 6-7. Model Subsurface Barrier Locations

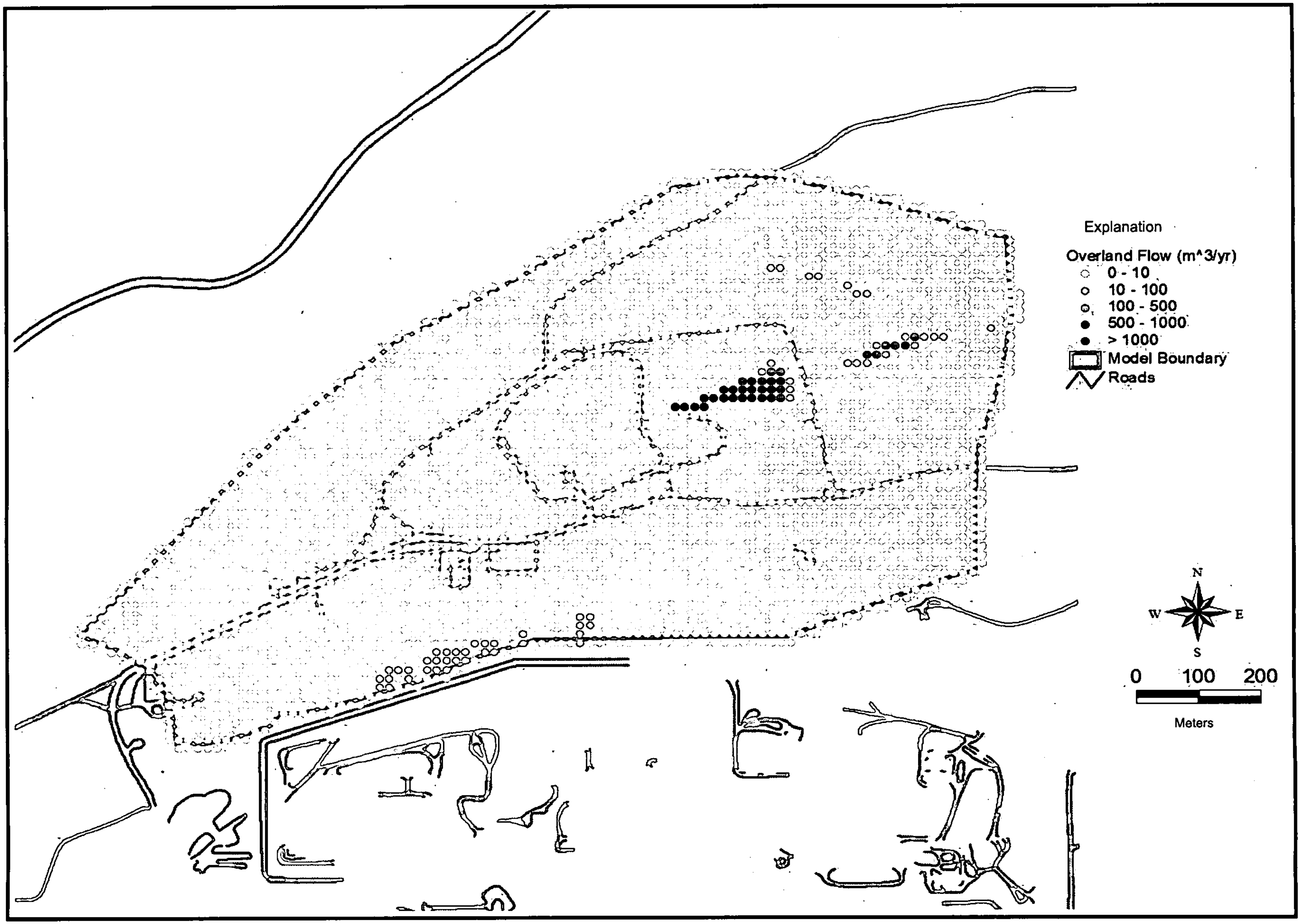


Figure 7-1. Model Overland Flow - 1994

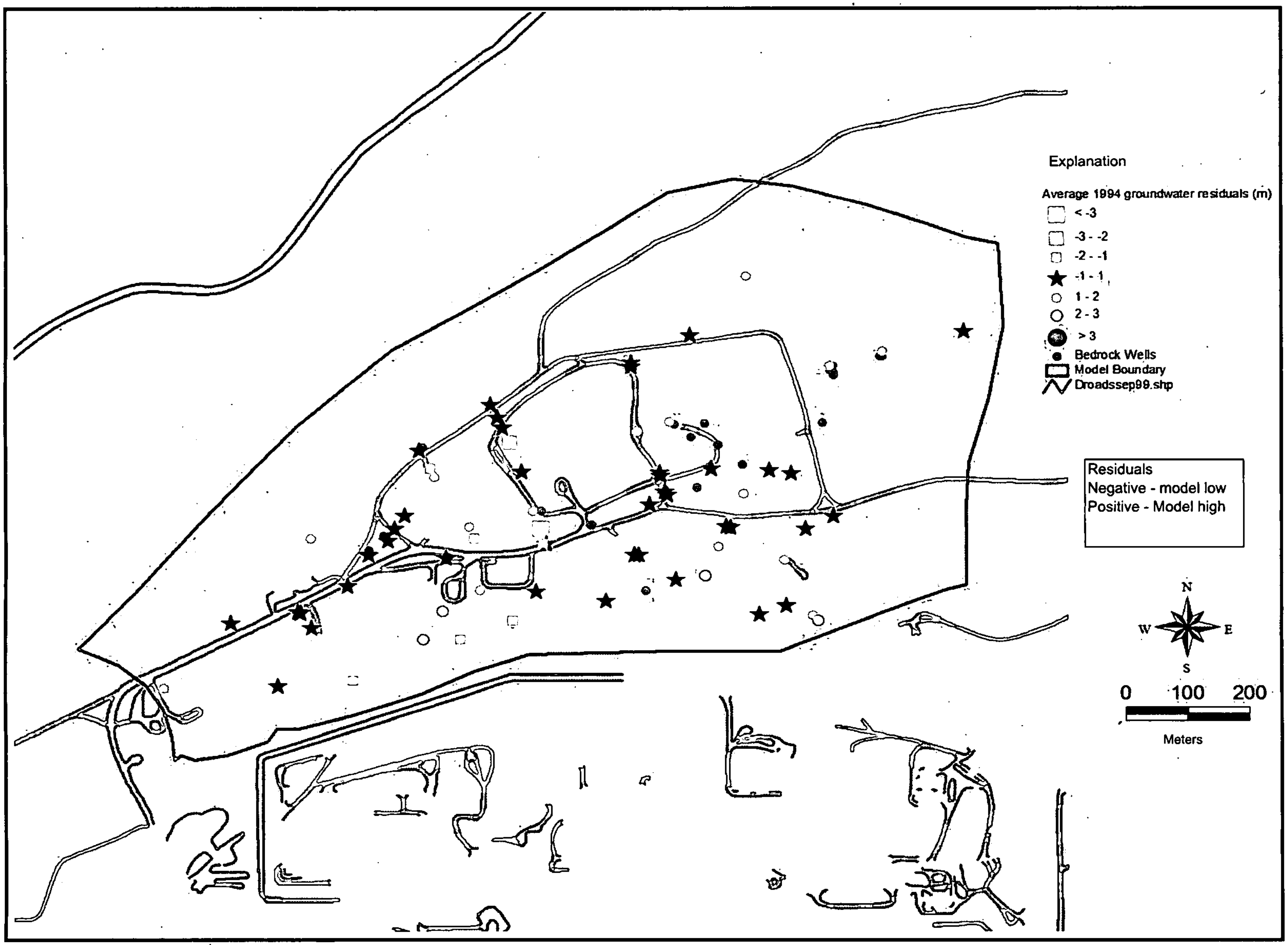


Figure 7-2. Average Model Groundwater Head Residuals - 1994

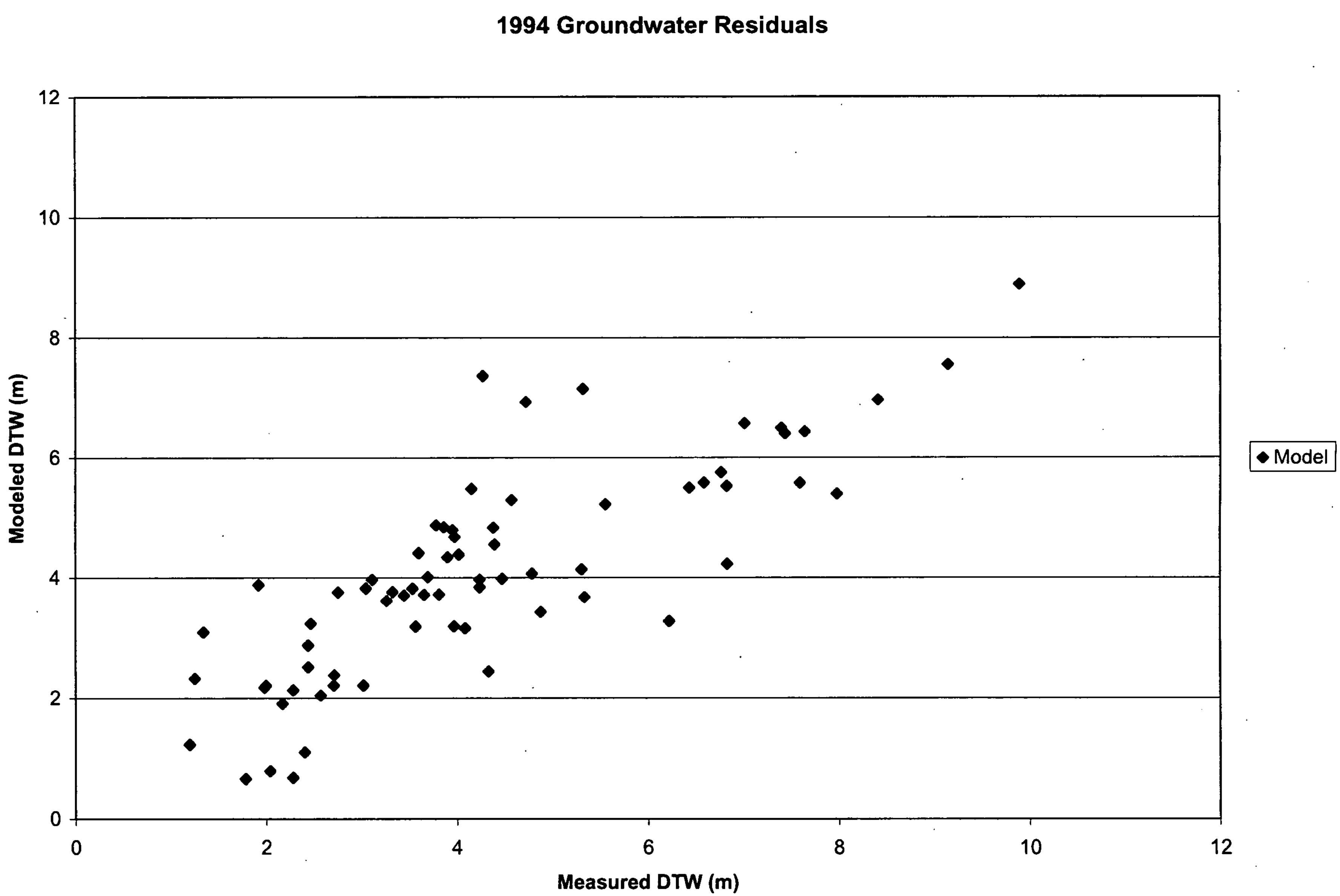


Figure 7-3. 1994 Groundwater Residuals

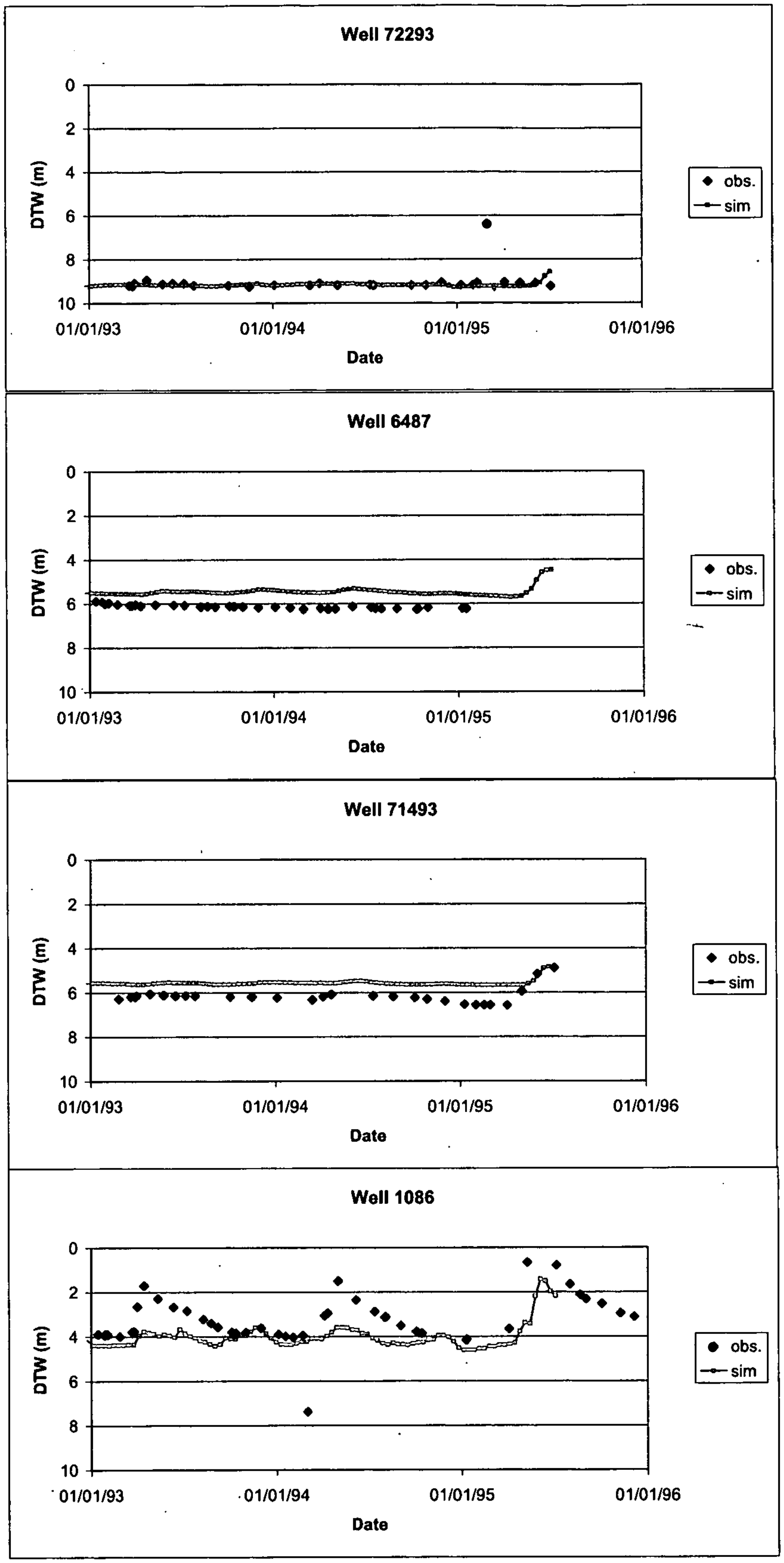


Figure 7-4. Modeled Well Response

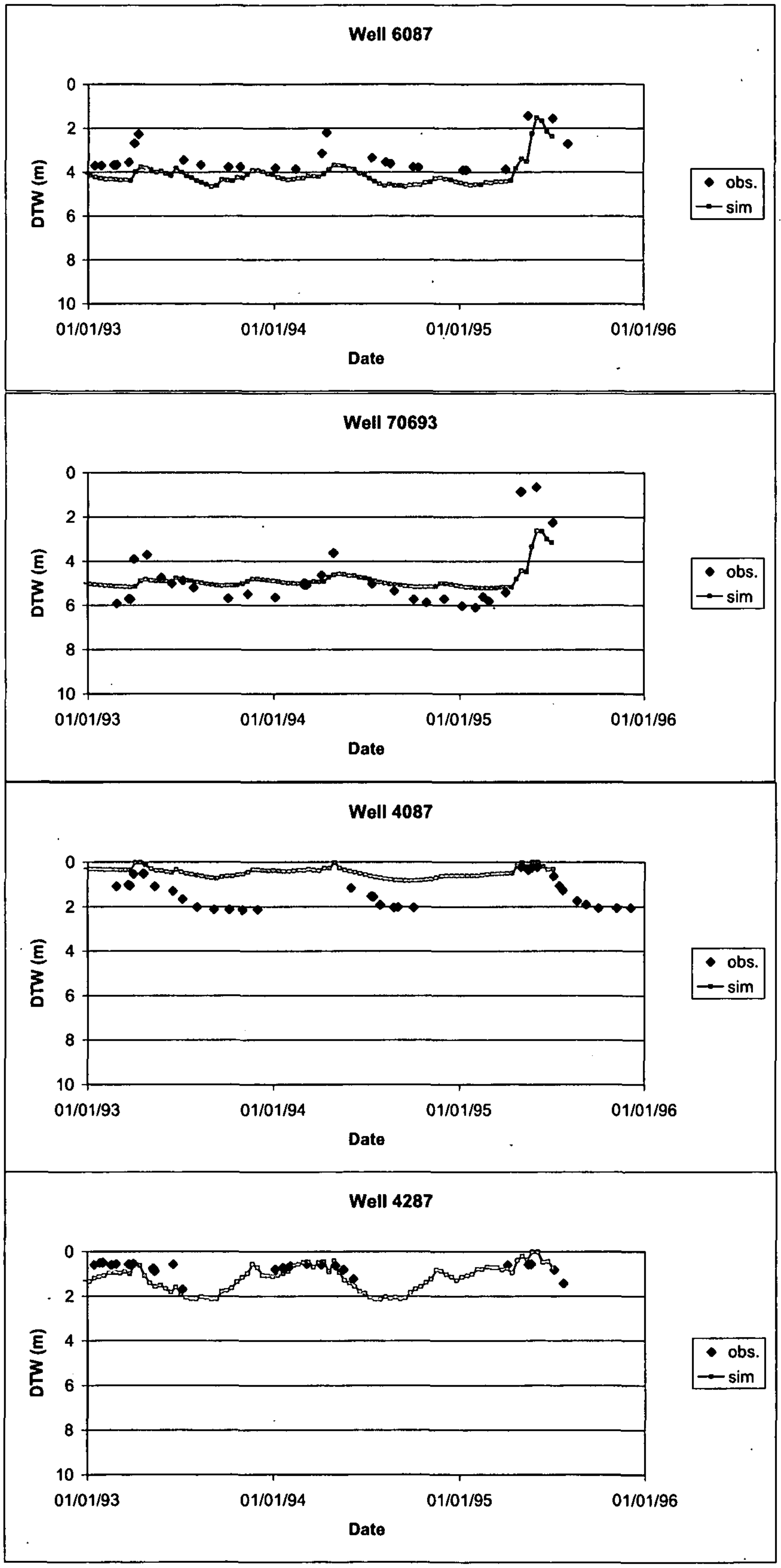
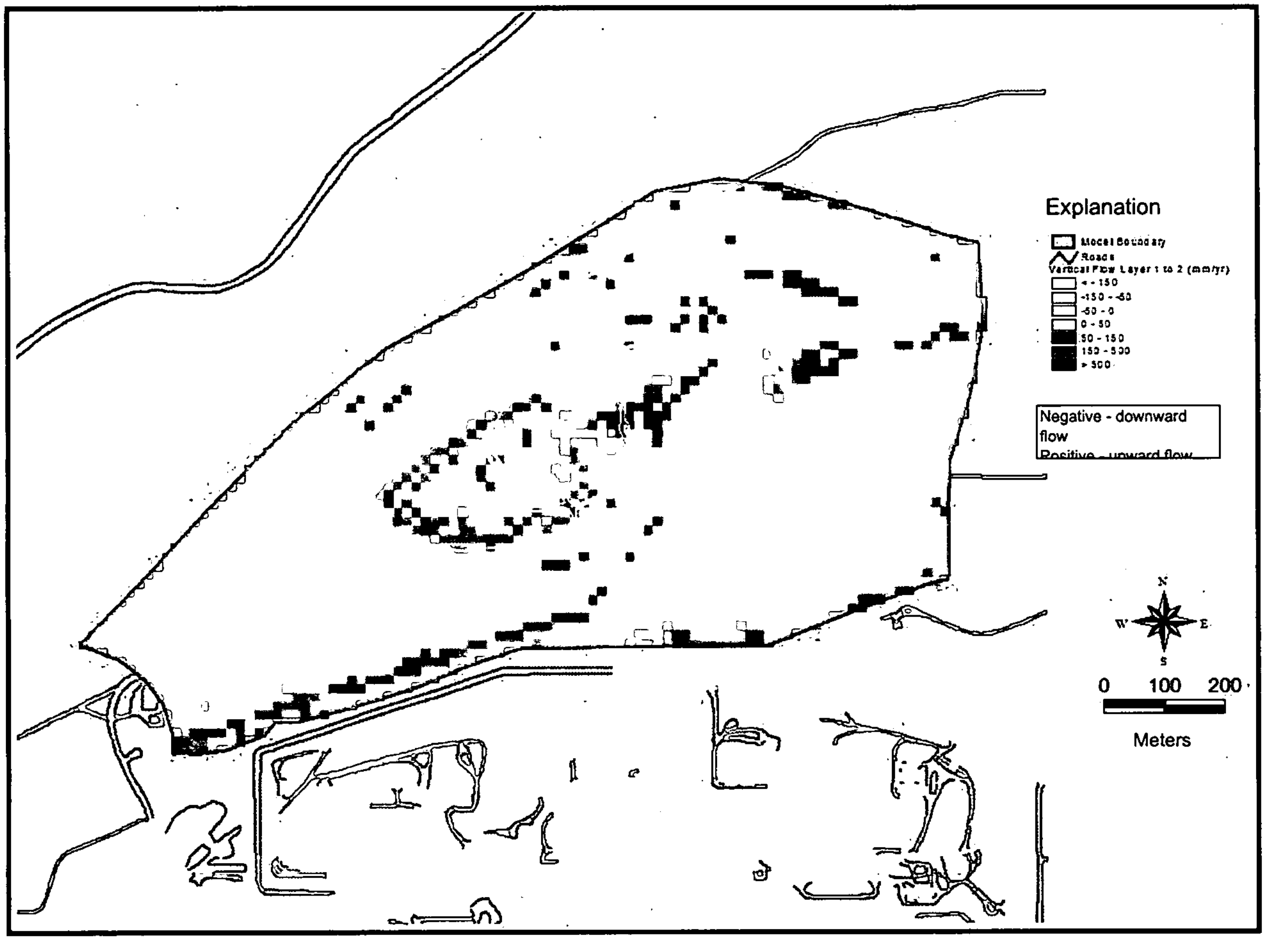


Figure 7-5. Modeled Well Response



Residuals
Negative - model low
Positive - Model high

Figure 7-6. Modeled Vertical Flow Layer 1 to 2 (1994)

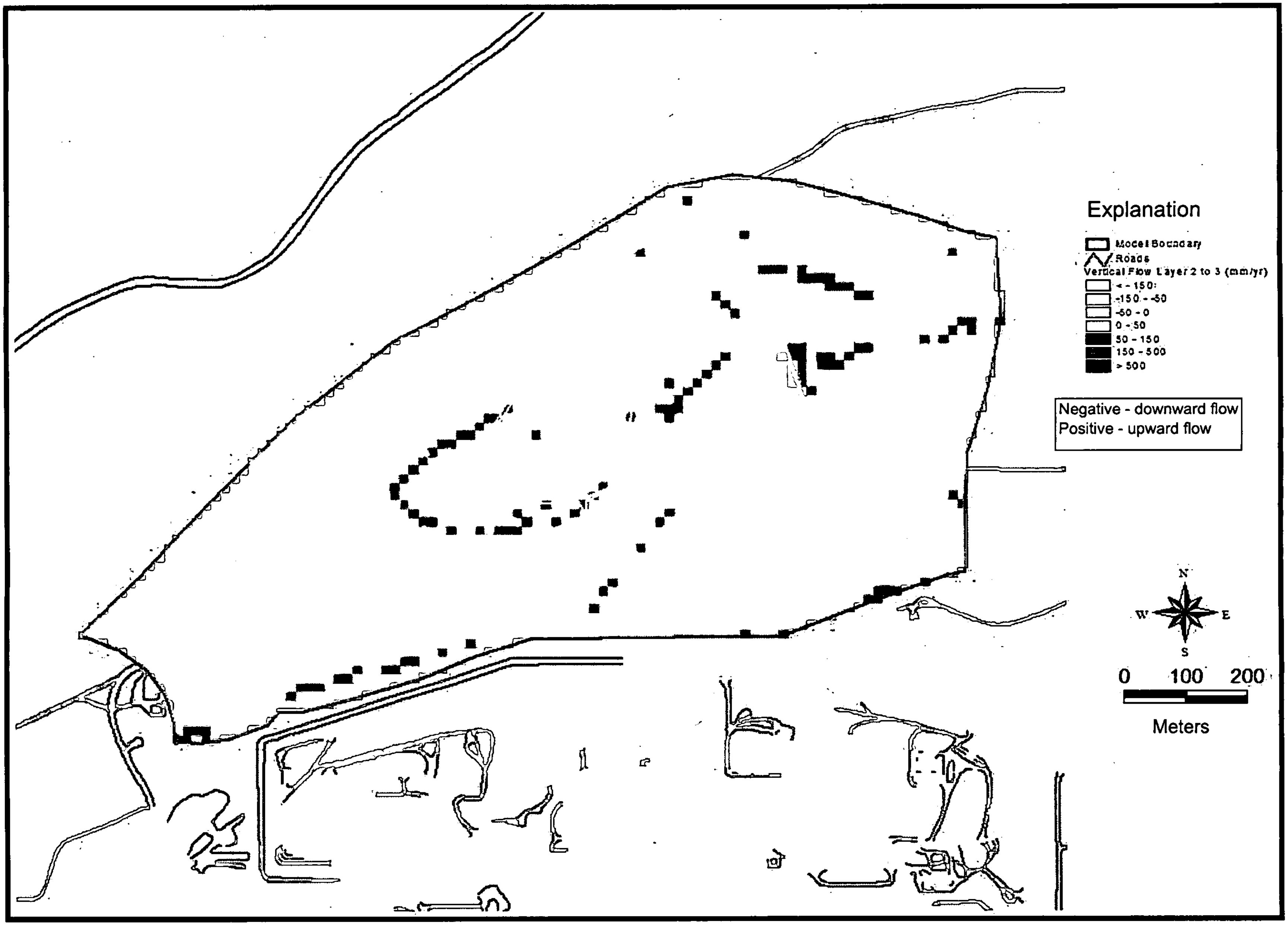


Figure 7-7. Modeled Vertical Flow Layer 2 to 3 (1994)

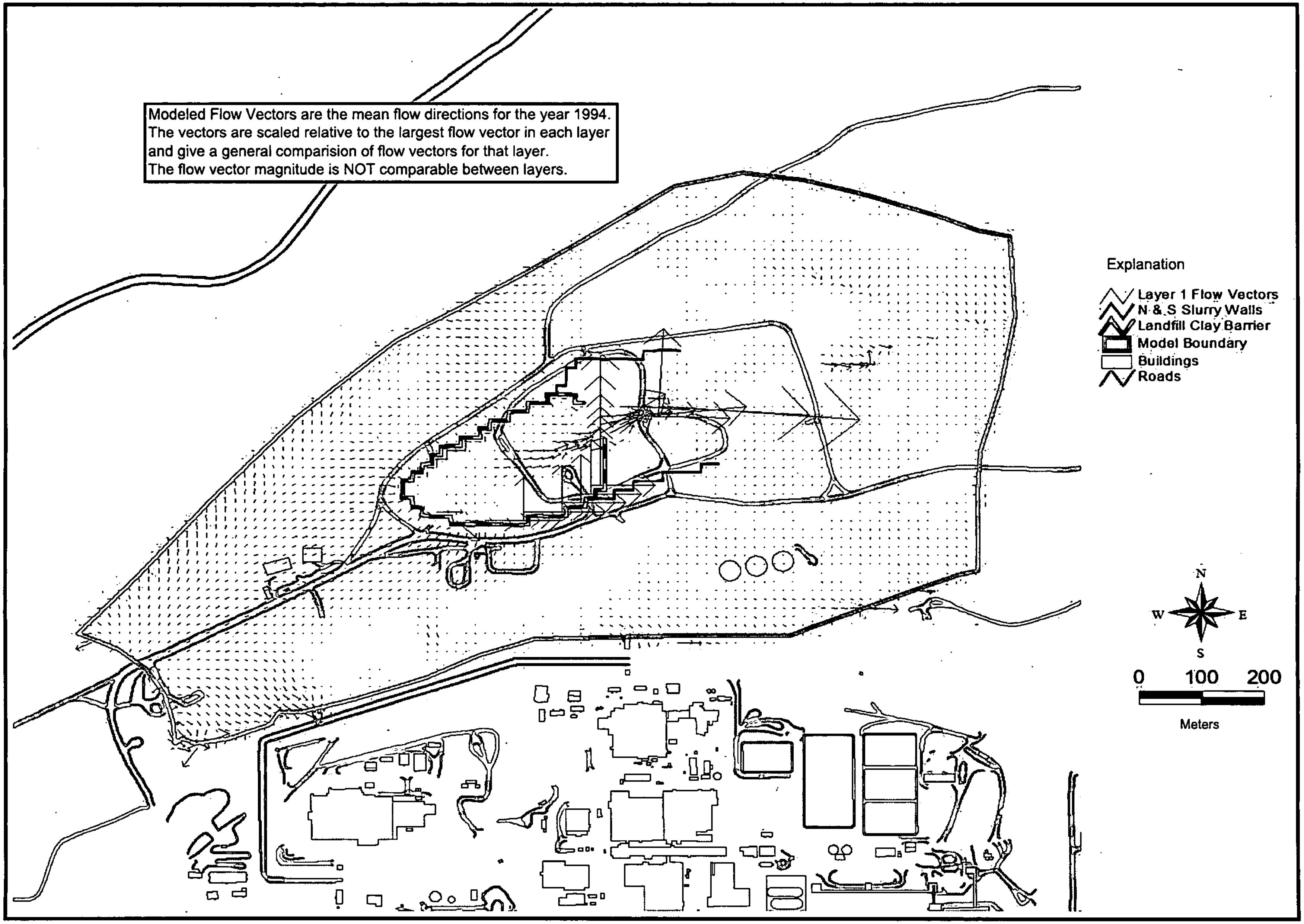


Figure 7-8. Modeled Horizontal Flow Layer 1 (1994)

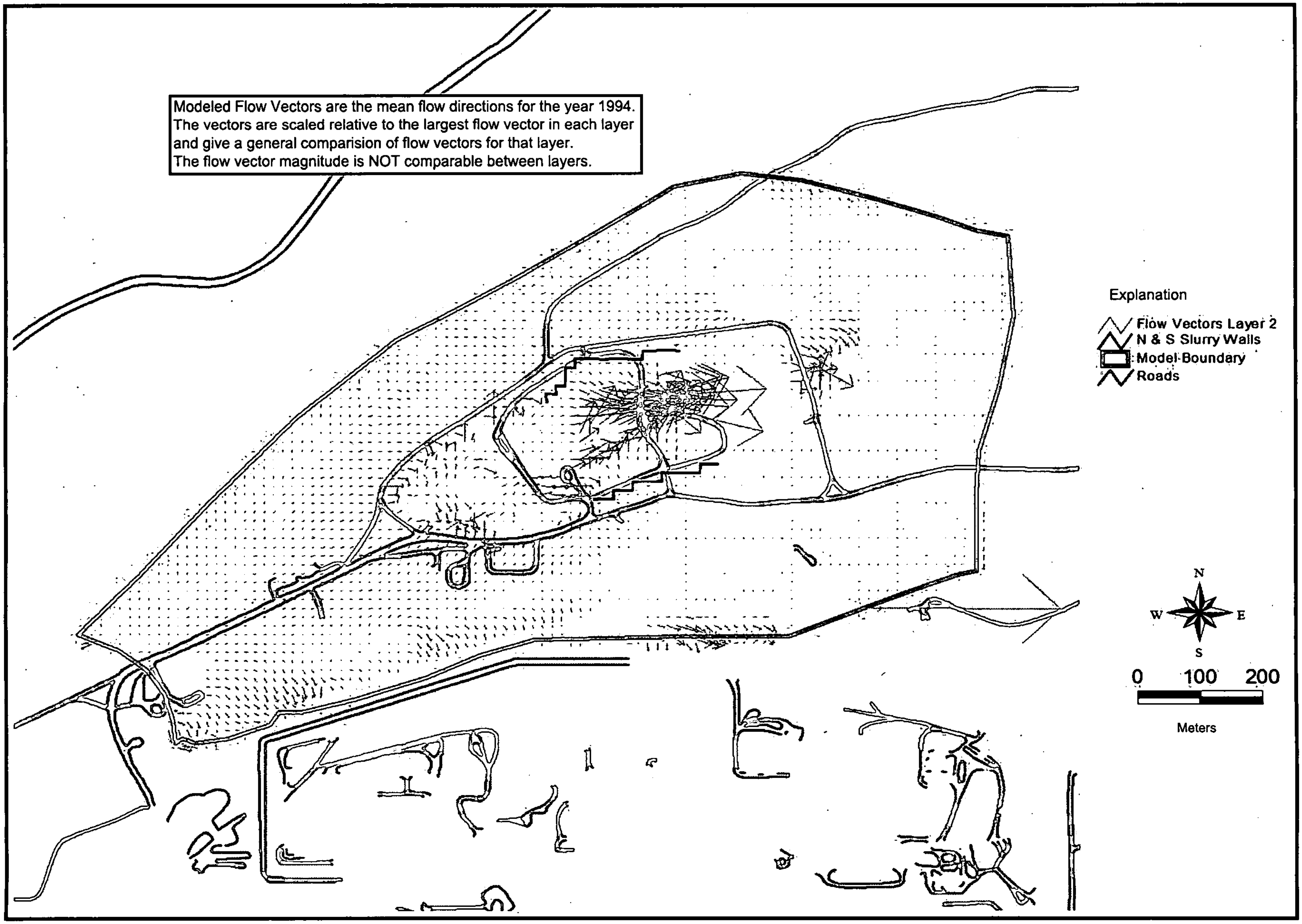


Figure 7-9. Modeled Horizontal Flow Layer 2 (1994)

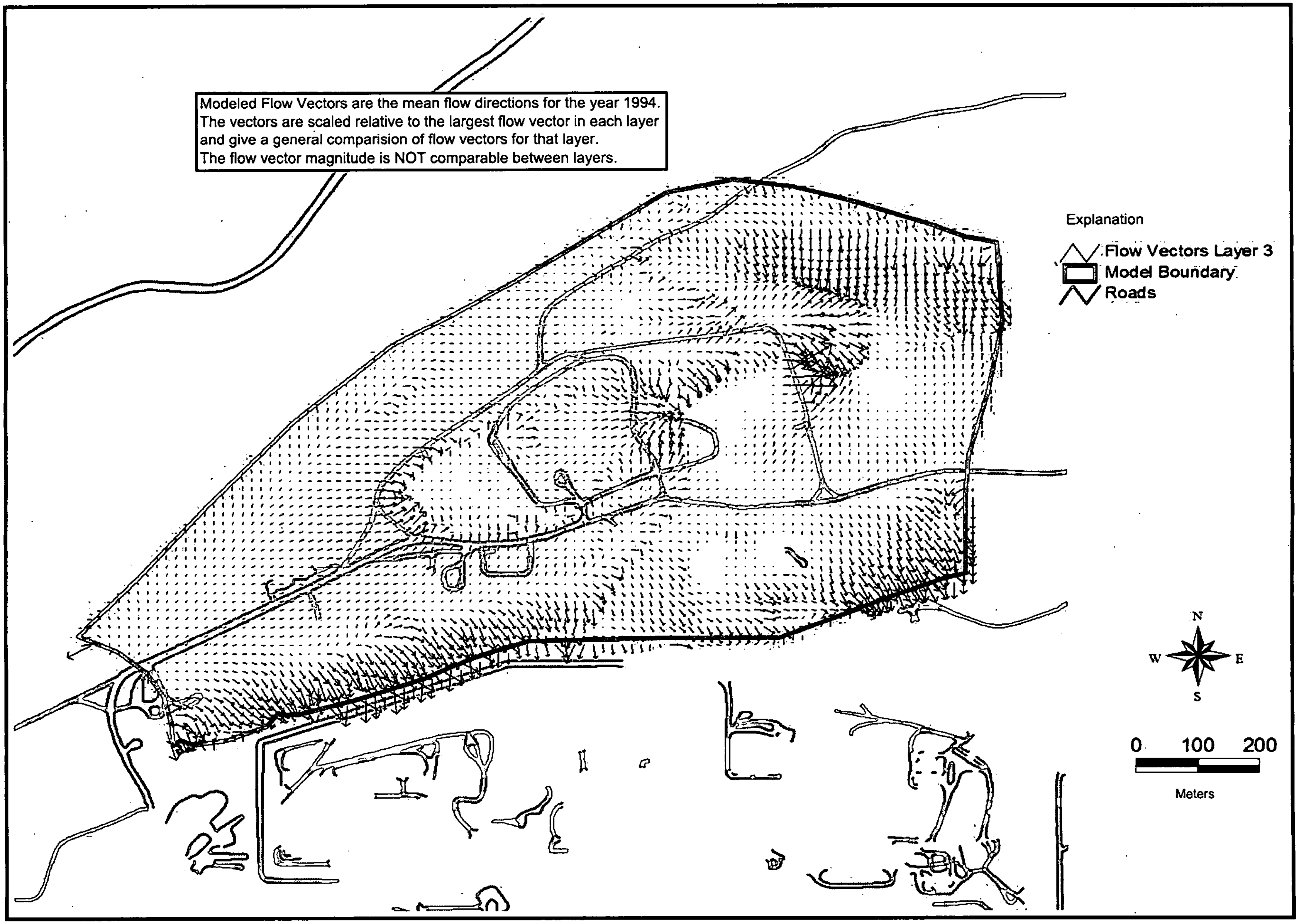


Figure 7-10. Modeled Horizontal Flow Layer 3 (1994)

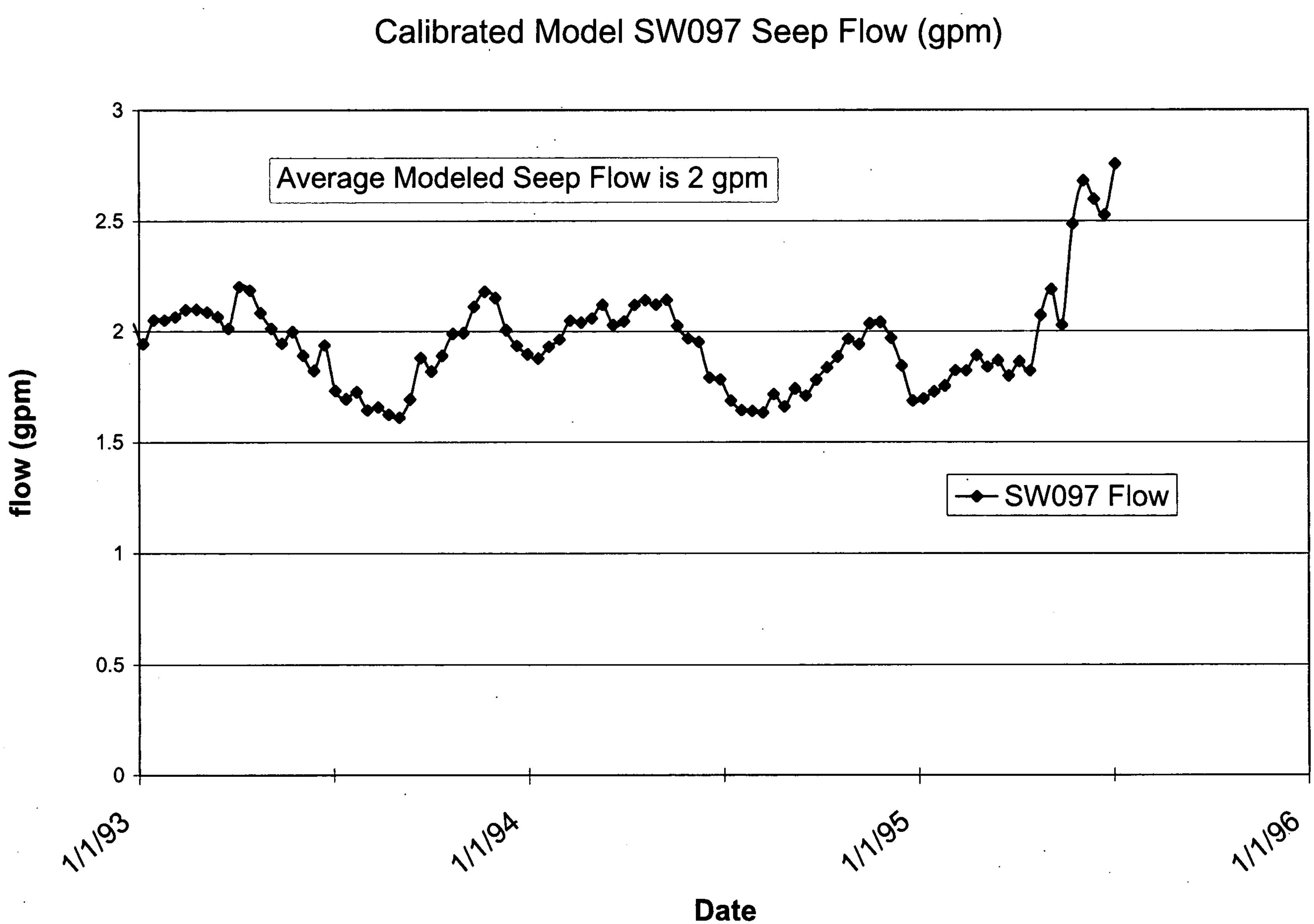


Figure 7-11. Modeled SW097 Seep Flow

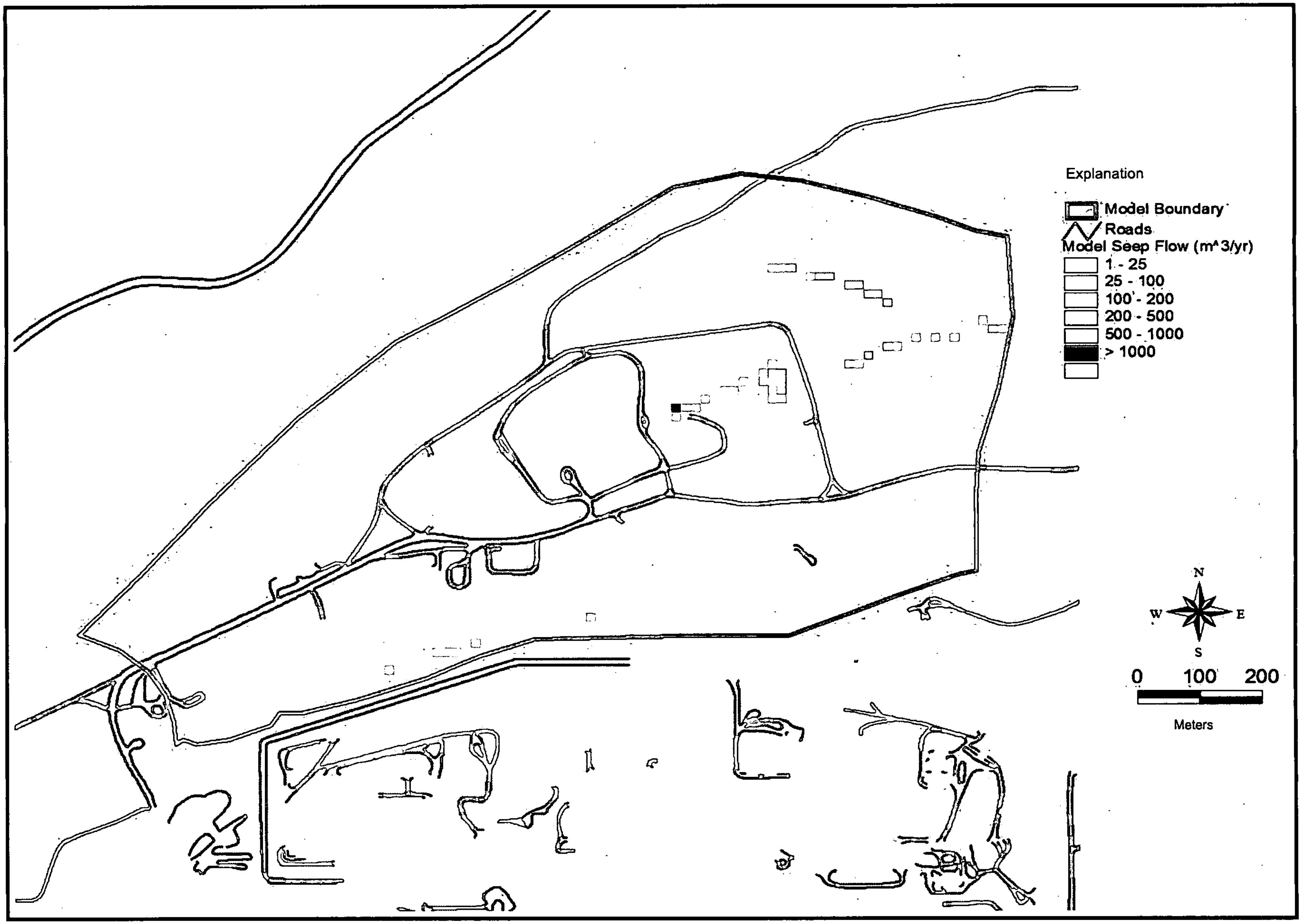


Figure 7-12. Modeled Seep Areas (1994)

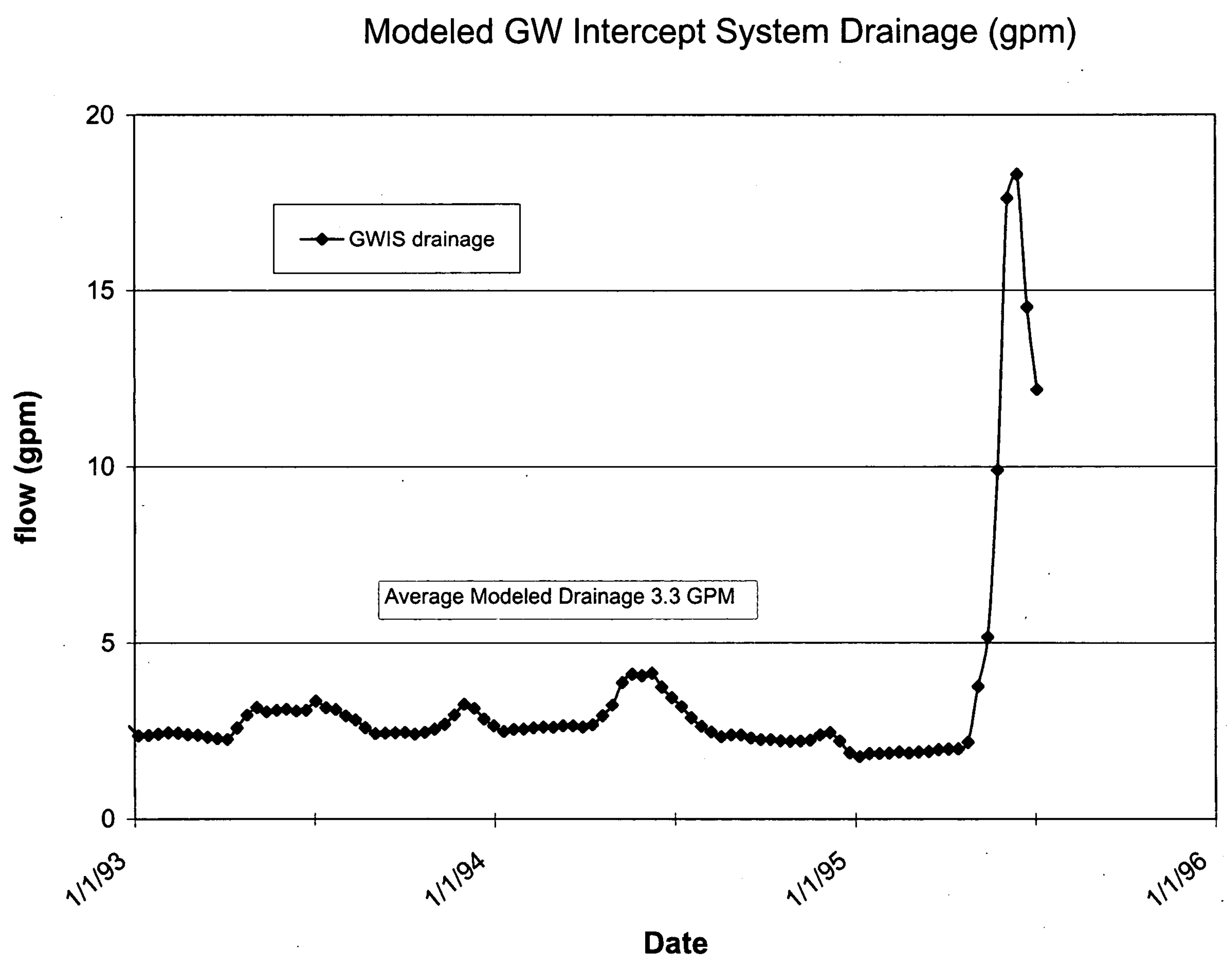


Figure 7-13 Model GWIS Discharge Rates

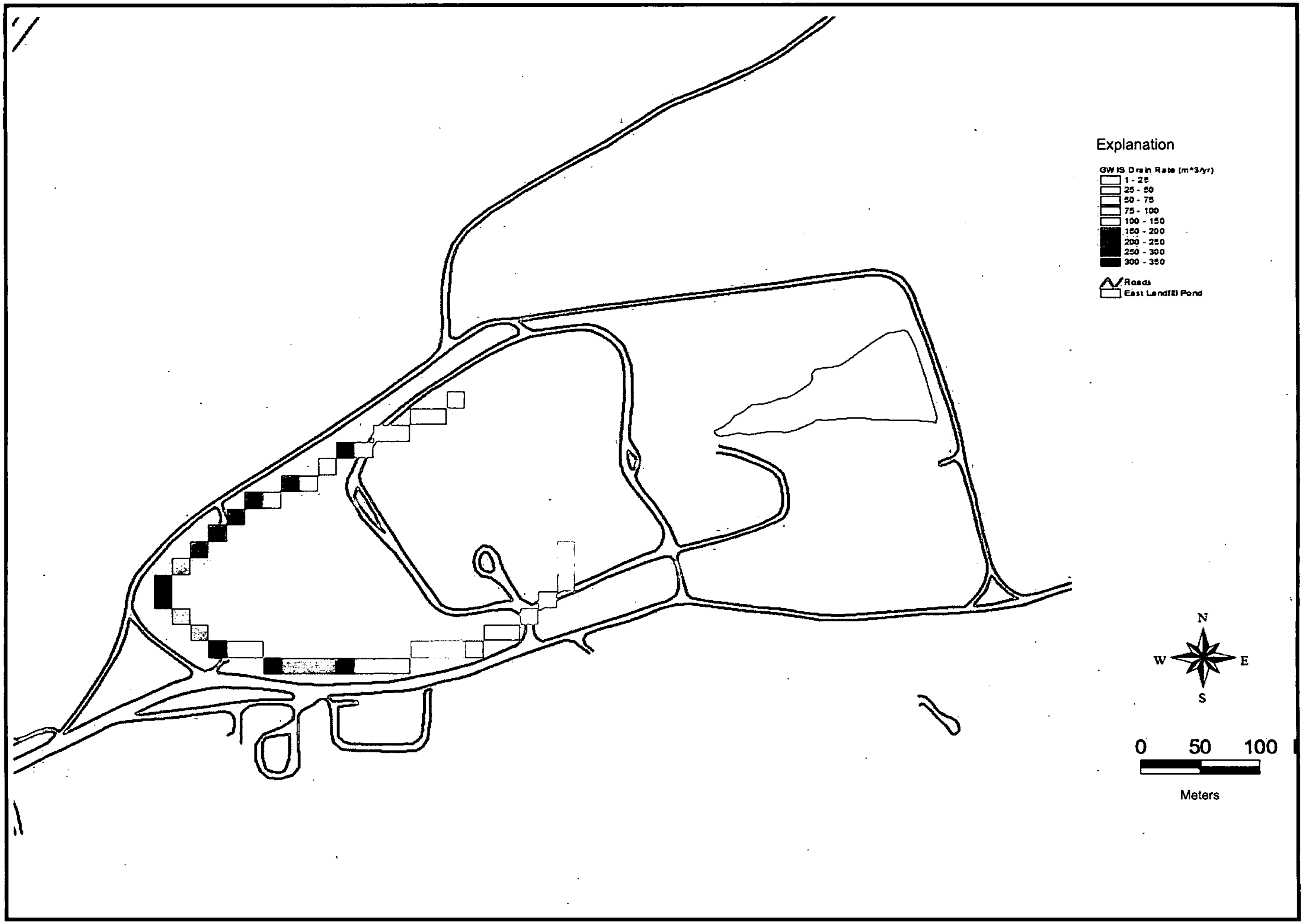


Figure 7-14. Modeled GWIS Volumes (1994)

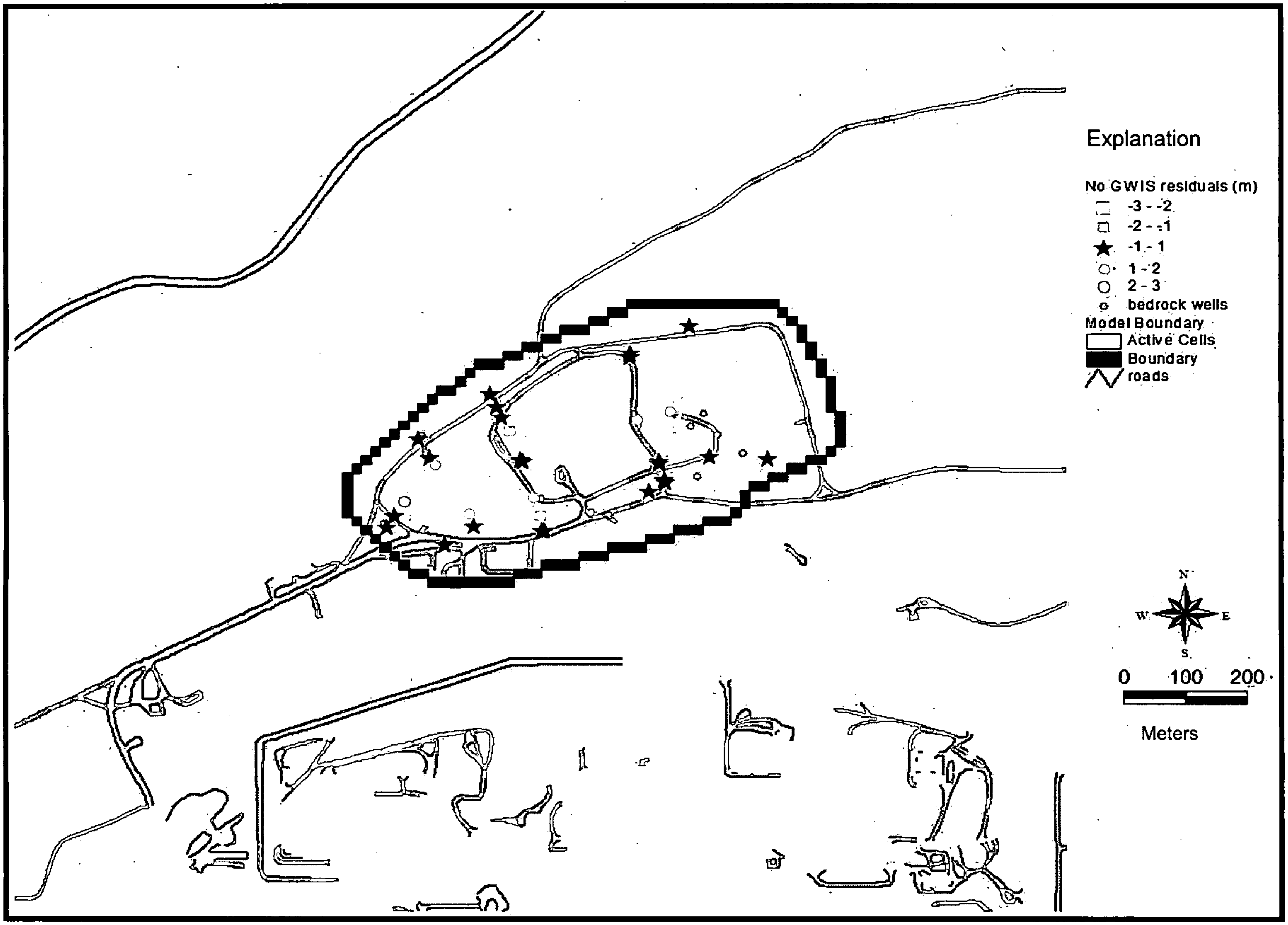


Figure 7-15. No GWIS System Groundwater Model Groundwater Head Residuals (1994)

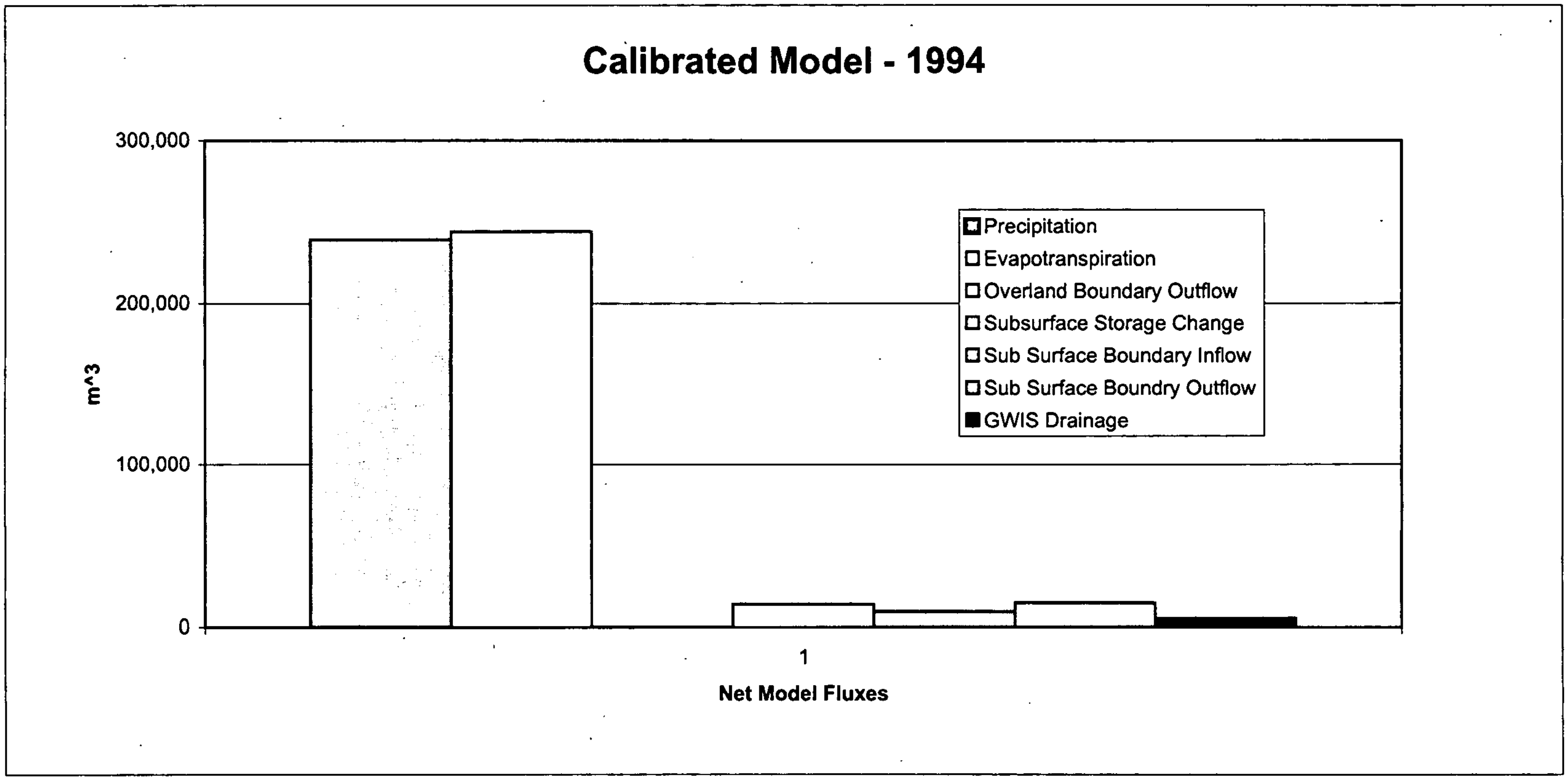


Figure 7-16. Model Water Balance for 1994

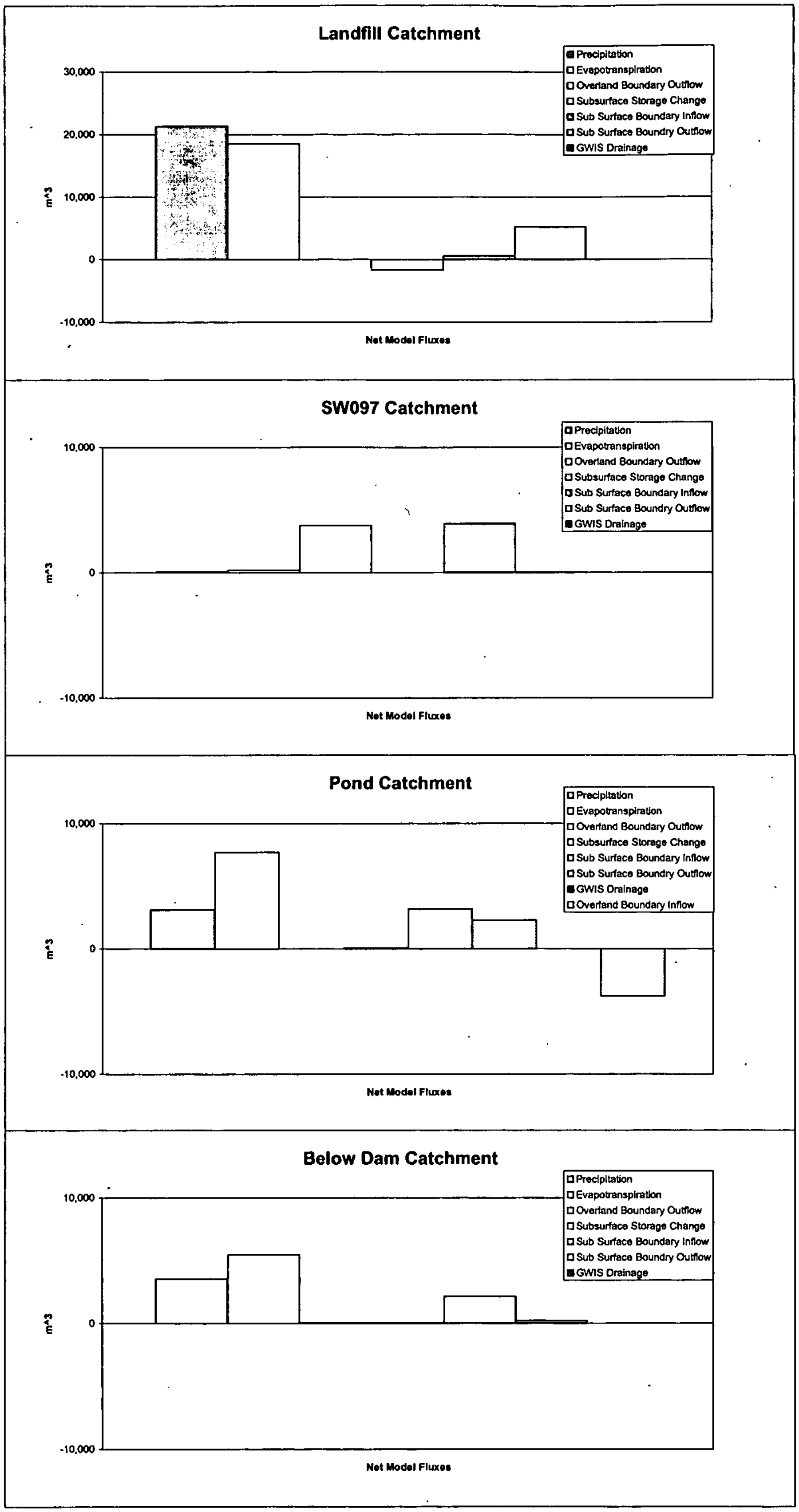


Figure 7-17. Focus Areas Modeled Water Balances (1994)

Figure 7-18. Modeled Total AET (1994)

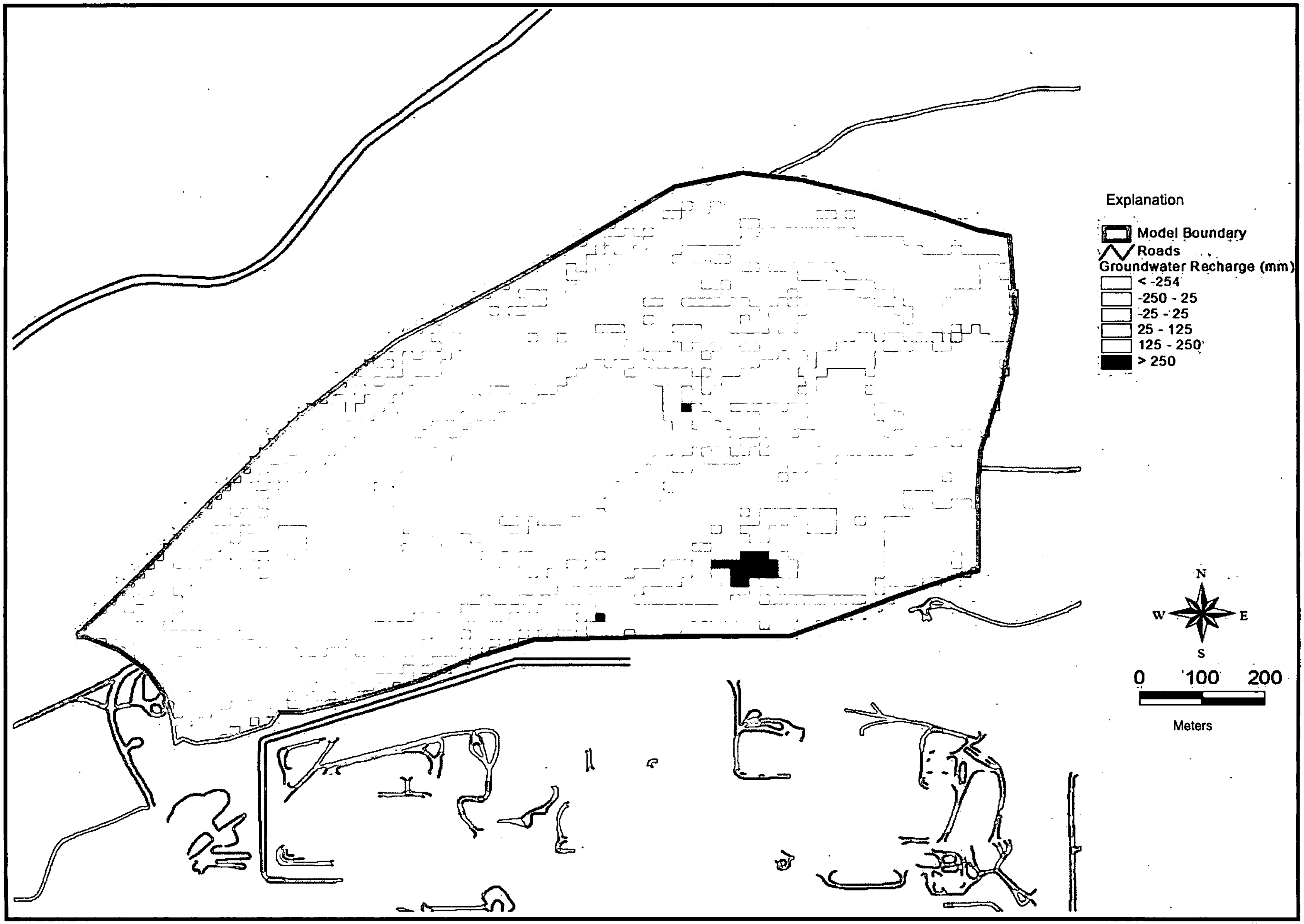


Figure 7-19. Modeled Total Recharge (1994)

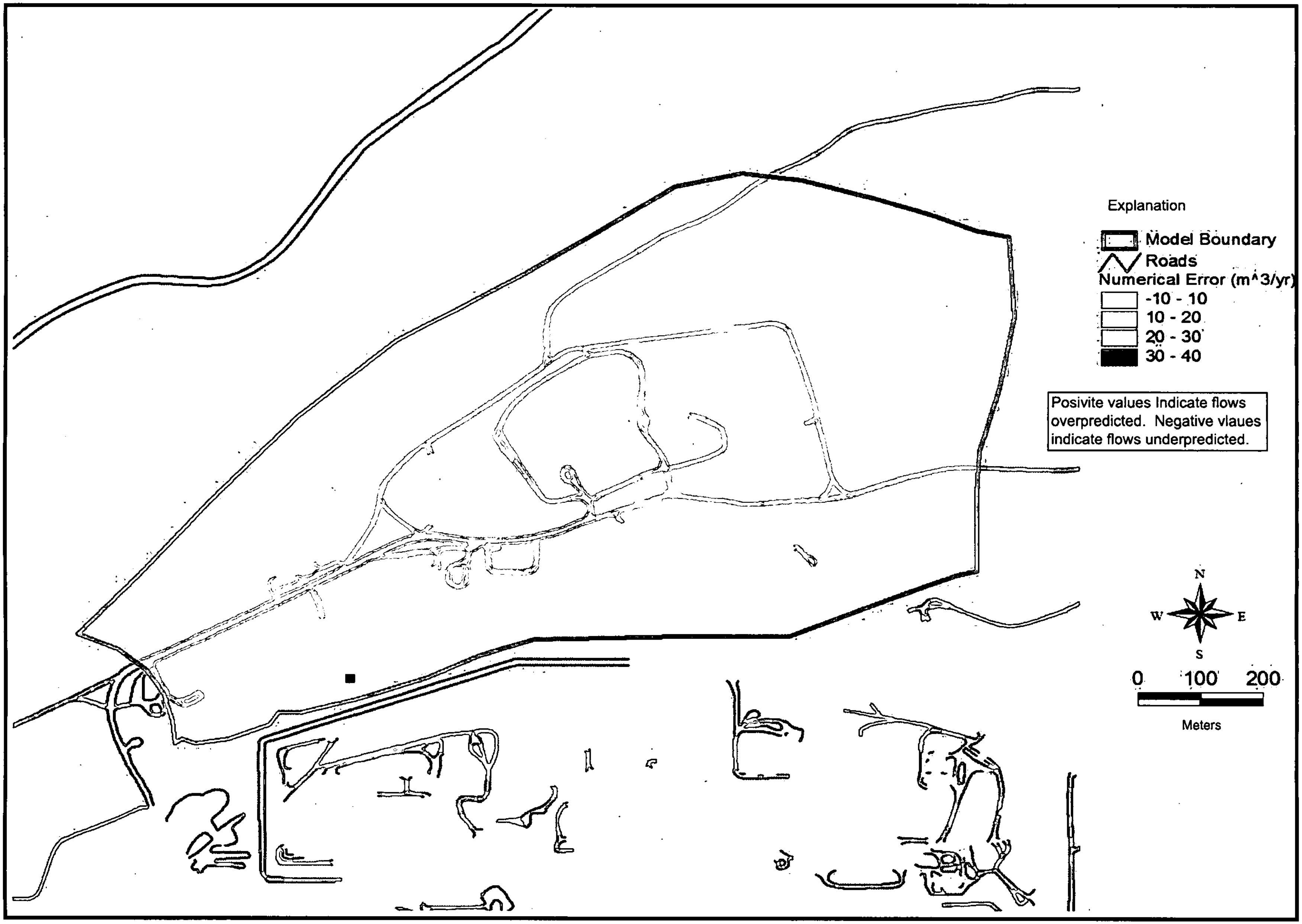


Figure 7-20. Total Annual Numerical Error (1994)

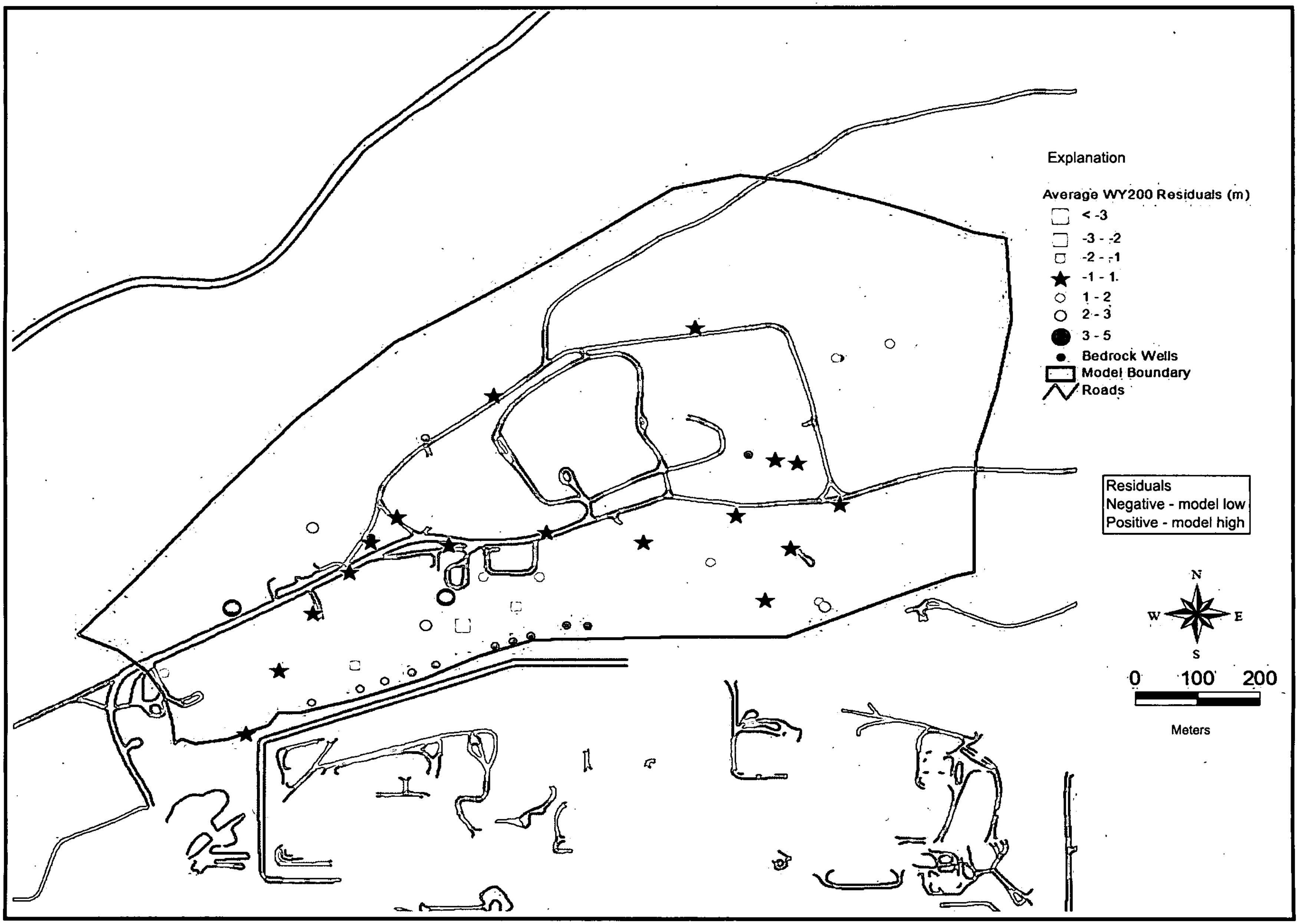


Figure 7-21. Validation Model Groundwater Residuals (WY2000)

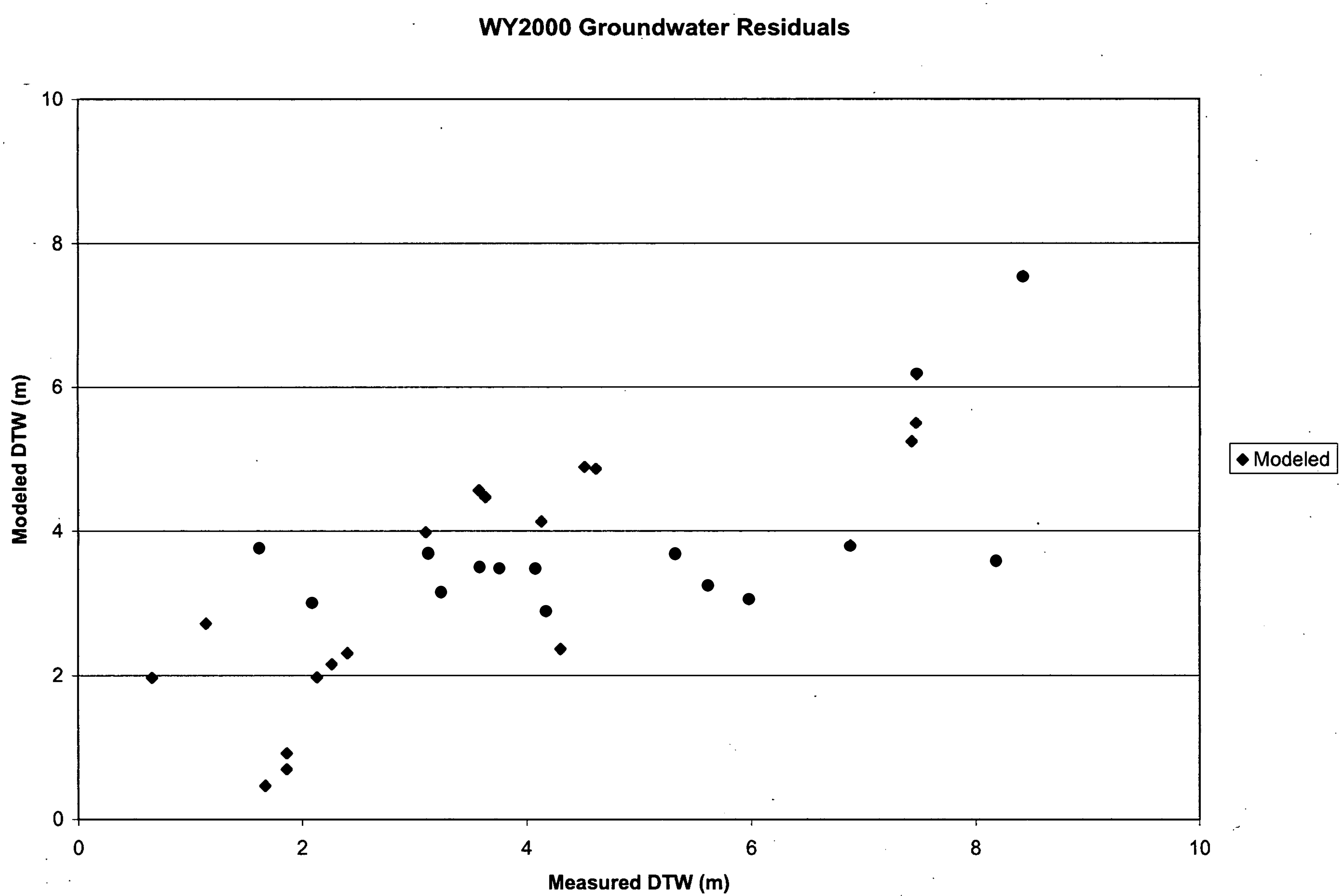


Figure 7-22. WY2000 Model Groundwater Residuals

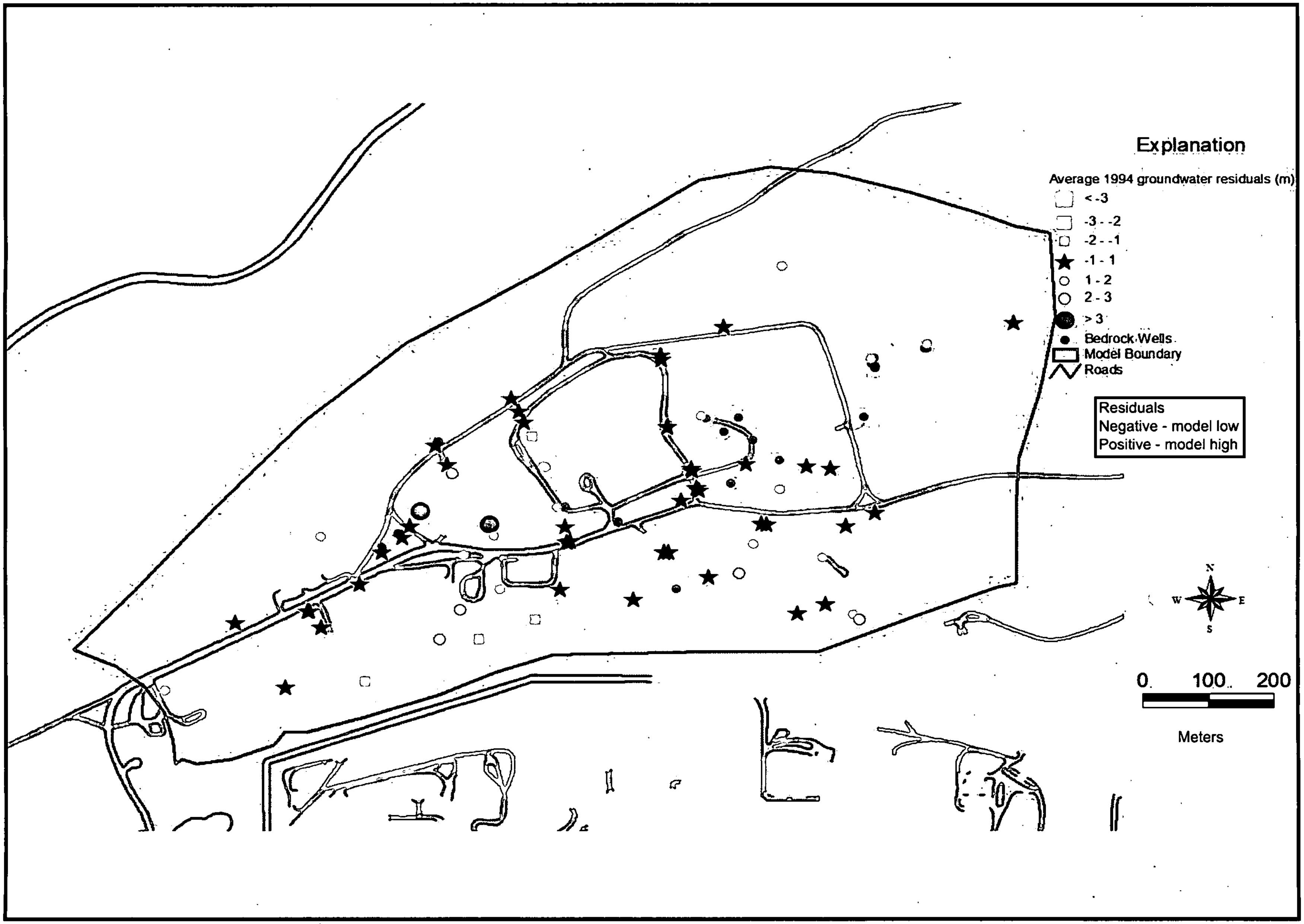


Figure 7-23. Average No Landfill Trench System Model Groundwater Residuals (1994)

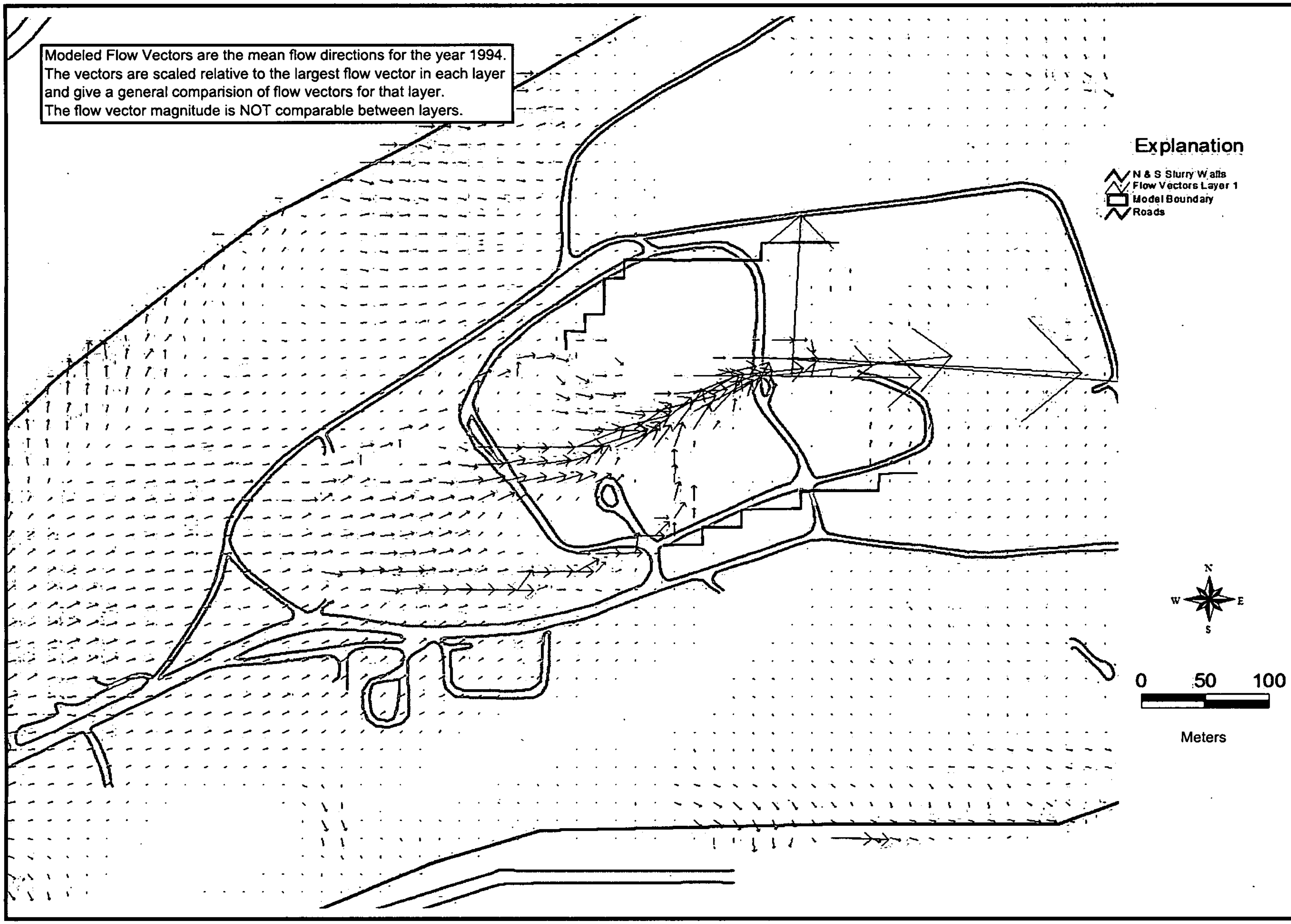


Figure 7-24. No Landfill Trench System Modeled Horizontal Flow Layer 1 (1994)

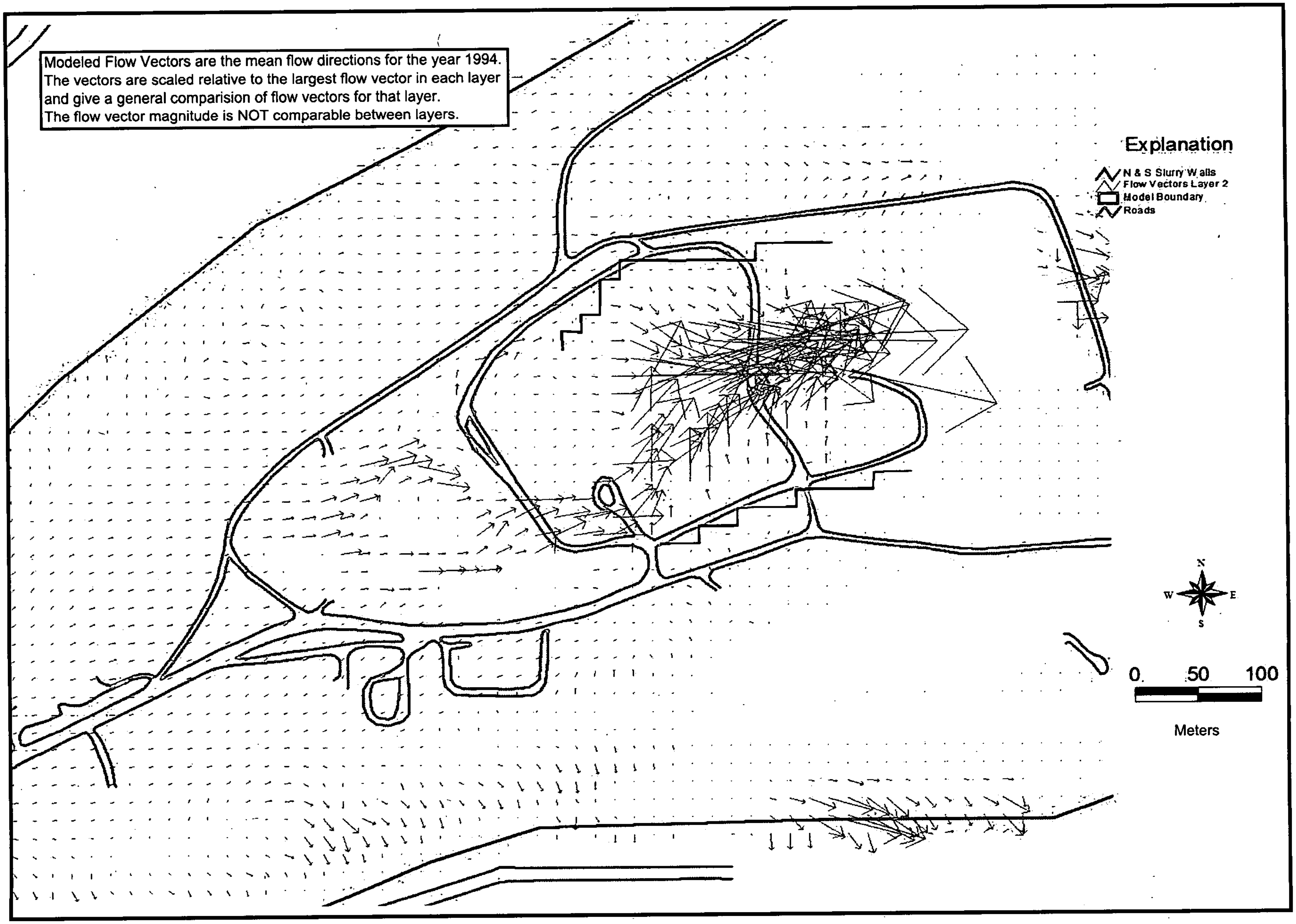


Figure 7-25. No Landfill Trench System Modeled Horizontal Flow Layer 2 (1994)

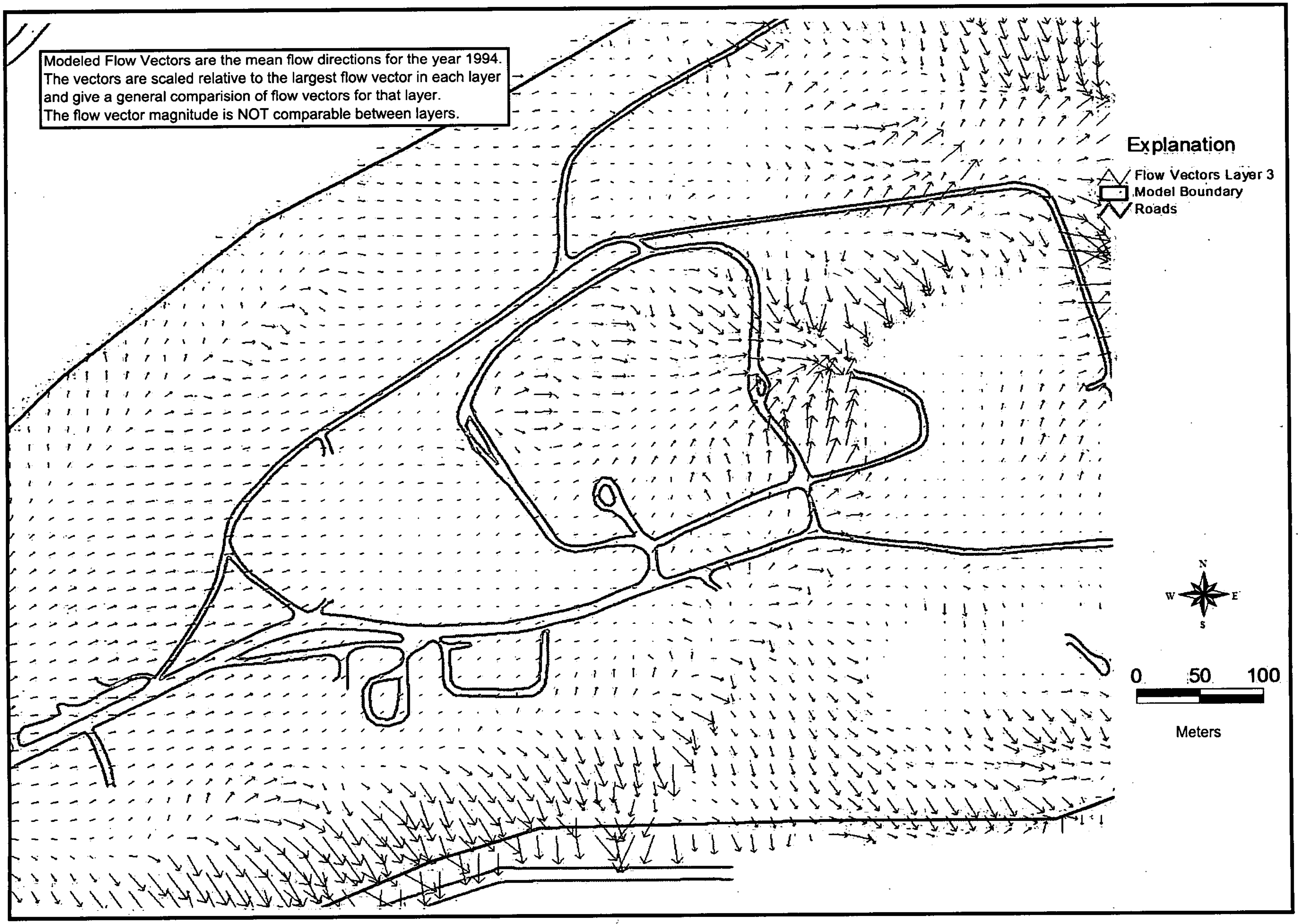


Figure 7-26. No Landfill Trench System Modeled Horizontal Flow Layer 3 (1994)

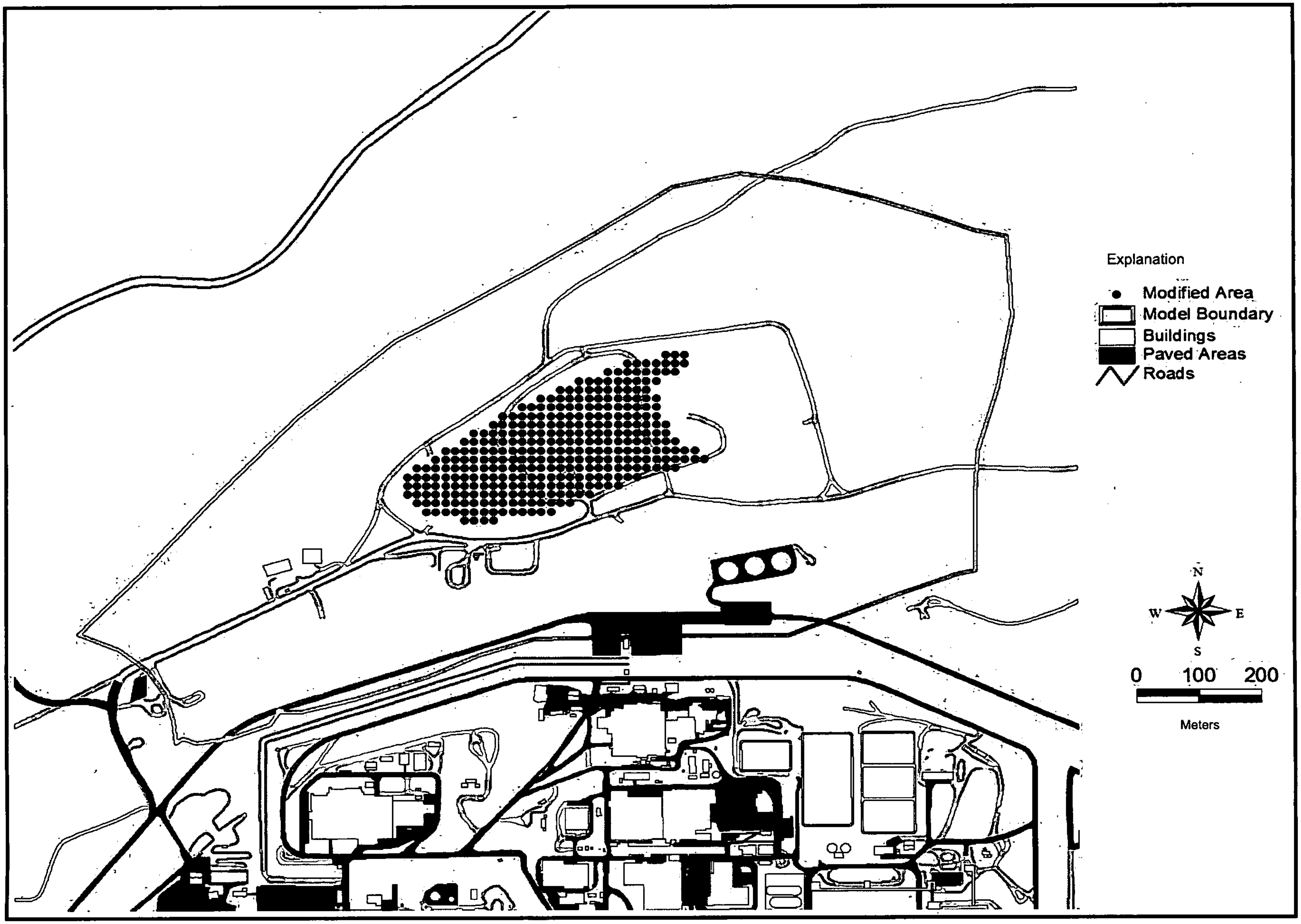


Figure 8-1. Modified Areas Present Landfill

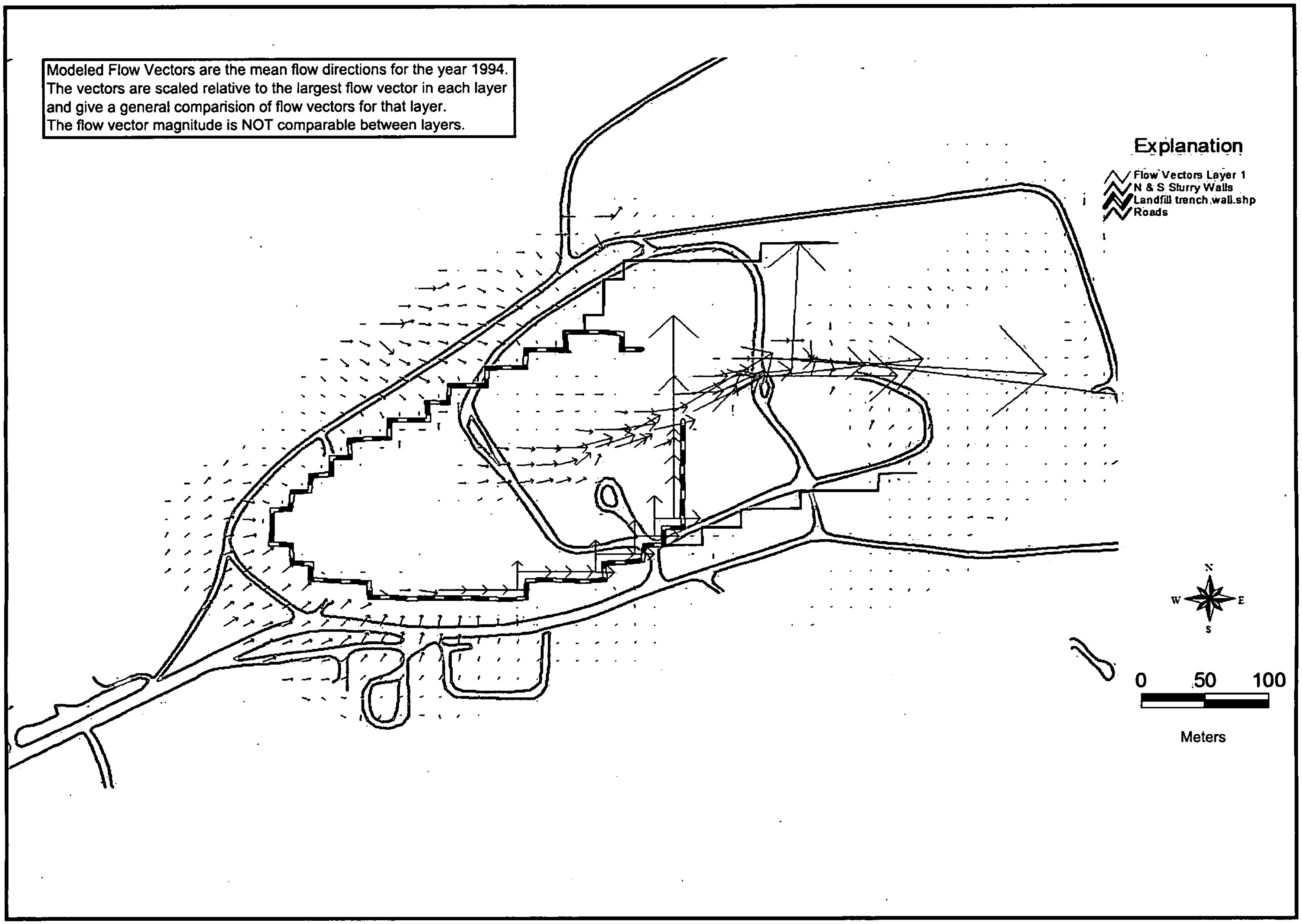


Figure 8-2. Reduced Recharge Modeled Horizontal Flow Layer 1

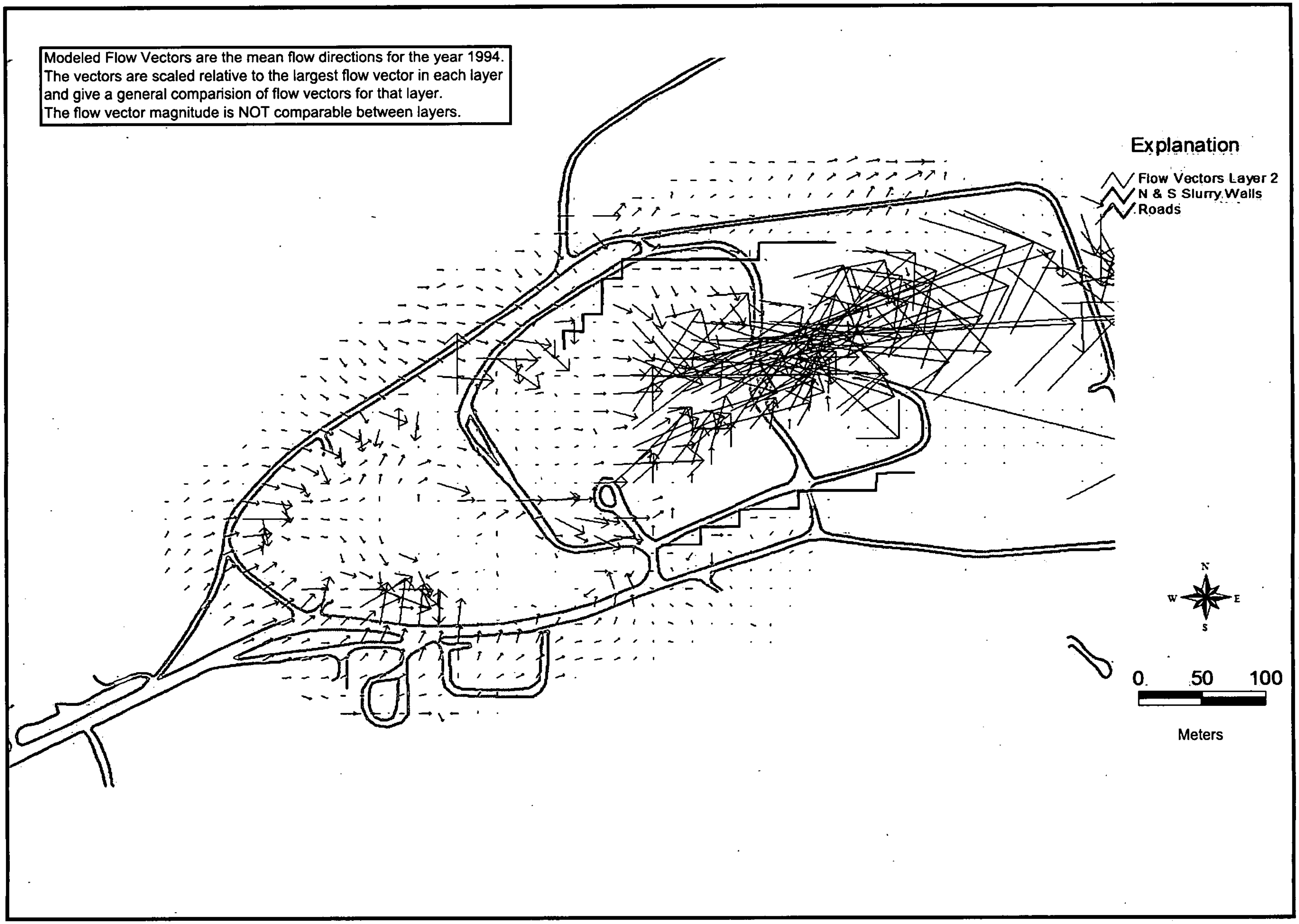


Figure 8-3. Reduced Recharge Modeled Horizontal Flow Layer 2

Appendix D
Water Quality Assessment for the Present Landfill

WATER QUALITY ASSESSMENT
FOR THE
PRESENT LANDFILL

July 15, 2003

ROCKY FLATS ENIVRONMENTAL TECHNOLOGY SITE
GOLDEN COLORADO

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EXECUTIVE SUMMARY

Surface water and groundwater quality at the Present Landfill, located within the Rocky Flats Environmental Technology Site (RFETS or Site), has been summarized and evaluated in support of the Interim Measure/Interim Remedial Action (IM/IRA) Decision Document for the Present Landfill. The evaluation has lead to the following conclusions:

1. High concentrations of some major anions in unconsolidated material and bedrock groundwater downgradient of the East Landfill Pond dam appears unrelated to releases from the landfill; other constituents released to groundwater by the landfill appear in this downgradient groundwater but at lower concentrations indicating attenuation is occurring during transport. The dam appears to contribute to this attenuation, and these observations are consistent with the local groundwater flow regime. Therefore, groundwater quality in the unconsolidated material beneath the landfill was further evaluated by examining data for wells at the toe of the landfill and immediately upgradient of this location.

2. Groundwater quality in the unconsolidated material beneath the landfill was compared to the Rocky Flats Cleanup Agreement (RFCA) Attachment 5 Surface Water Standards and Action Levels (ALs) as a first measure in the evaluation of groundwater contamination and its potential for impacting surface water quality. Although arsenic concentrations were above the surface water ALs, the concentrations were very low and fluctuated about the Attachment 5 Tier II groundwater AL of 0.05 mg/l. Also, arsenic concentrations did not exceed the surface water AL in the seep that discharges from the eastern face of the landfill. Uranium-233,234 and uranium-238 concentrations were above the surface water AL of 10 pCi/g (sum of the isotopes) in well 786; however, the concentrations were below Site background levels and the uranium isotopic ratio suggest the uranium is natural. Although gross beta concentrations exceeded the surface water standard in well 72293, the levels were still below background, and compliance with surface water ALs was achieved for all Site-specific radionuclides. Also, gross beta and uranium concentrations meet the surface water ALs in the seep discharge.

3. With the exception of barium and zinc, organic and inorganic compounds as well as radionuclides were at or below the surface water ALs in the seep that discharges from the landfill. Barium and zinc were present at SW00196 at concentrations just above their respective surface water ALs; however the concentrations were below Site background for seeps. Also, the barium and zinc concentrations were below the RFCA Preliminary Remediation Goals, and downgradient surface water quality at station GS03 (the Site boundary point of compliance for surface water quality) meets the surface water ALs for these metals. Benzene concentrations continue to fluctuate about the surface water AL, which is expected from a measurement sensitivity perspective because the benzene surface water AL (0.0012 mg/l) is near the PQL (0.001 mg/l). Accordingly, the current seep treatment system does not appear to be necessary to meet surface water ALs.

1. INTRODUCTION

Surface water and groundwater quality at the Present Landfill, located within the Rocky Flats Environmental Technology Site (RFETS or Site), has been summarized and evaluated in support of the Interim Measure/Interim Remedial Action (IM/IRA) Decision Document for the Present Landfill. Specifically, the objectives of this assessment are three fold:

1. Evaluate downgradient groundwater quality relative to surface water ALs as a first measure in the evaluation of groundwater contamination and its potential for impacting surface water quality.
2. Determine if the quality of the leachate-contaminated groundwater seeping from the landfill is compliant with surface water ALs. The water quality of the seepage is to be evaluated to determine if the current passive aeration treatment system should continue to be operated.

2. BACKGROUND

A number of studies have been undertaken to characterize the hydrogeology and water quality at the Present Landfill. Also, upgradient and downgradient water quality is routinely monitored and evaluated at the landfill in accordance with the Site Integrated Monitoring Plan (IMP). The findings from these studies are summarized in the IM/IRA Decision Document. With respect to the IMP monitoring, the IMP data evaluation indicates significant differences in upgradient and downgradient groundwater quality with respect to sulfate, TDS, calcium, copper, lithium, magnesium, molybdenum, selenium, vanadium, uranium-233/234, uranium-235, and uranium-238. Downgradient groundwater quality is measured downgradient of the East Landfill Pond dam. The increase in metals and major cations and anions in downgradient groundwater, particularly in the shallow bedrock, has been attributed to a secondary contaminant source or to other natural processes involving evapotranspiration, upwelling of deep bedrock groundwater, and mineralization along the groundwater flow path. These conjectures have been offered because the water quality in the unconsolidated material beneath the landfill does not suggest landfill leachate is the source for these apparent impacts to groundwater quality downgradient of the East Landfill Pond dam.

A seep exists at the toe of the landfill. A seep interception and treatment system was constructed in 1996 and modified in 1998 to remove volatile organic compounds (VOCs) from the water. The modification was a change from granular activated carbon treatment to passive aeration treatment. The organic contaminant levels in the seep water are low, often below the Practical Quantitation Limits (PQLs), i.e., non-detected.

3. APPROACH

Previous studies and monitoring have indicated that the increase in dissolved solids downgradient of the East Landfill Pond dam may be unrelated to a release of leachate. Accordingly, the approach to the groundwater quality assessment was to first portray this geochemical condition in the area in an effort to better understand the condition, and second, to examine the groundwater quality data for wells in unconsolidated material within and immediately downgradient of the landfill as an alternative method to assess impacts to groundwater from release of landfill leachate. Lastly, the seep water quality data at the landfill was evaluated to determine compliance with the RFCA surface water ALs.

In this assessment, groundwater water quality within the unconsolidated material within the landfill was compared to surface water ALs as a first measure in evaluating the potential for impacts to surface water quality, recognizing that evaluating groundwater concentrations to surface water standards is not required under RFCA. Groundwater quality is also compared to Attachment 5 Tier II groundwater ALs as another benchmark to evaluate the impact of leachate release to groundwater.

Appendix A presents concentration data for all detections of organic, inorganic, and radiochemical constituents in unconsolidated material groundwater within and near the landfill seep. Appendix B provides this type of data for surface water at the landfill seep. Appendix C provides concentration time-series plots for those constituents in the unconsolidated material groundwater where the surface water standard was exceeded. Appendix D provides the concentration time-series graphs for surface water at the seep.

4. REVIEW OF UNCONSOLIDATED MATERIAL AND UHSU BEDROCK GROUNDWATER CHEMISTRY

Within the landfill wastes, groundwater flows locally towards the leachate collection system (outwards) and then to the former western pond location, where it then flows eastward towards the landfill seep area and discharges to the surface. It appears that most, if not all, saturated zone groundwater within the UHSU and waste material upgradient of the seep are discharged to the surface at this location. Outside the landfill, groundwater flow directions closely mimic surface topography and the weathered bedrock surface, with flow being directed toward the centerline of the No Name Gulch drainage. Accordingly, groundwater quality along (or near) the centerline of the landfill/drainage is most likely to be impacted by the landfill. Wells that have been selected for water quality review from upgradient to downgradient (see Figure 1) are:

- Unconsolidated Materials* – 70393, 72393, 72293, 786, 4087, 52894
- UHSU Bedrock – 70493, B206789, B206889, B206989

* Two wells have been omitted from this analysis. There is no data for well 30700, and only one sample has been collected from well 30600 for organic analysis. [There were no organic compounds detected above the surface water ALs in this well].

Sulfate, nitrate, and chloride have been chosen as indicators of the changes to the inorganic chemistry of groundwater from upgradient to downgradient locations at the landfill. These constituents are mobile and the solids formed with sodium, magnesium, and calcium have high solubilities.

As shown in Figures 2 and 3, sulfate concentrations in both unconsolidated material and shallow (Upper Hydrostratigraphic Unit [UHSU]) bedrock groundwater increase in the downgradient direction. [The figure legends show the wells in an upgradient to downgradient order.] Upgradient sulfate concentrations are very low in both unconsolidated material and UHSU bedrock groundwater, with concentrations less than 50 mg/l. In the unconsolidated material directly beneath the landfill (wells 72393 and 72293), sulfate concentrations are also similar to upgradient conditions. However, in the vicinity of the landfill pond, sulfate concentrations increase significantly in both unconsolidated material and UHSU bedrock groundwater. Downgradient of the landfill dam, the sulfate concentrations again significantly increase and are as high as 500 mg/l in unconsolidated material well 4087, and 3000 mg/l in UHSU bedrock well B206989.

The distribution of nitrate concentrations is similar to sulfate (Figure 4 and 5) with a few notable differences. In unconsolidated material groundwater, the highest concentrations of nitrate are upgradient and the lowest concentrations are within the landfill. Nitrate concentrations are slightly elevated (relative to those in the landfill) downgradient of the landfill and landfill dam but are generally less than 1 mg/l (the surface water standard is 10 mg/l). In the UHSU bedrock groundwater, upgradient nitrate concentrations are very low, increase slightly immediately downgradient of the landfill, and increase significantly downgradient of the landfill dam, with the highest concentrations observed in well B206889 (in excess of 100 mg/l).

As shown in Figure 6 and 7, the pattern of an increasing concentration downgradient of the landfill is not as pronounced for chloride as it is for sulfate and nitrate in the UHSU bedrock groundwater, and the pattern of an increasing concentration downgradient of the landfill is not observed in the unconsolidated material groundwater. In the unconsolidated material groundwater, chloride appears to increase in a downgradient direction <u>within</u> the landfill, with the highest concentrations observed at well 786 just downgradient of the landfill. Concentrations of chloride in unconsolidated material groundwater are lower downgradient of the East Landfill Pond dam.

Chemcial Oxidation Demand (COD) concentrations were also examined as another potential indicator parameter of impacts to groundwater by the landfill. COD is a measure of dissolved organics. As shown in Figure 8, COD concentrations are significantly higher in the unconsolidated material groundwater within the landfill than they are upgradient and downgradient. Concentrations of COD in UHSU bedrock groundwater increase in a downgradient direction but the highest concentrations are only 10% of the concentrations in the unconsolidated material groundwater beneath the landfill (Figure 9).

The above cited time-series plots (Figures 2 through 9) indicate the groundwater chemistry at the selected wells has been relatively static, i.e. there are no significant trends over time. With respect to chloride and COD, the data appears to indicate that the landfill releases these constituents to unconsolidated material groundwater and to a lesser extent UHSU bedrock groundwater. In the unconsolidated material groundwater, the concentrations attenuate downgradient, and the dam appears to contribute to this attenuation. Unlike chloride and COD, sulfate and nitrate concentrations in the unconsolidated material groundwater within the landfill are very low and similar to or lower than upgradient conditions. The high concentrations of nitrate in UHSU bedrock groundwater and sulfate in both unconsolidated material and

UHSU bedrock groundwater downgradient of the dam strongly suggest the increase in these constituents is unrelated to the landfill.

These observations are consistent with the groundwater flow modeling results that indicate most of the flow in unconsolidated material and UHSU groundwater downgradient of the dam originates from the north and south, and not from the landfill (west). This explains attenuation of constituents released from the landfill, and increases in concentrations of other constituents unreleated to releases from the landfill. Accordingly, as an alternative to using data from wells downgradient of the dam for assessing impacts to groundwater from the landfill, existing data for wells at the seep or immediately upgradient of the seep was examined (see Section 5).

5. ASSESSMENT OF IMPACTS TO GROUNDWATER QUALITY IN UNCONSOLIDATED MATERIAL WITHIN THE PRESENT LANDFILL

Two wells upgradient of the pond that are located near the seep and are completed in unconsolidated material have been chosen for a detailed assessment of potential impacts to groundwater from release of leachate from the landfill; well 786 at the seep, and well 72293 immediately upgradient of the seep. Both wells are strategically located to intercept any contamination that may be entering the groundwater system within the landfill.

5.1 Organics

As shown in the Appendix A summary table, benzene, bis(2-ethylhexyl)phthalate, chloroethane, naphthalene, trichloroethene, and vinyl chloride exceeded the surface water ALs in unconsolidated material groundwater. However, as shown in the Figures in Appendix C (Figures C-1 – C-4), concentrations were either 1) decreasing over time (benzene and chloroethane in well 72293), or 2) rarely detected or not detected (benzene and choroethane in well 786, naphthalene and vinyl chloride in wells 786 and 72293). [Bis(2-ethylhexyl)phthalate and trichloroethene concentrations were not plotted because there was only one detection for each compound, and the concentrations were just above their respective surface water ALs]. The last several measurements of benzene and chloroethane in well 72293 were below their respective surface water ALs. In summary, organic compound concentrations in unconsolidated material groundwater were either decreasing, and thus the quality was improving, or were already at or below the surface water ALs.

5.2 Inorganics

As shown in the Appendix A summary table, aluminum, arsenic, barium, lead, nickel, and sulfide exceeded the surface water ALs in unconsolidated material groundwater. As shown in Figures C-5 through C-9, with the exception of arsenic, concentrations of these metals were decreasing. [Nickel concentrations were not plotted because nickel only exceeded the AL in well 786, and it represents the only detection of nickel in that well.] Although arsenic concentrations were not decreasing, the concentrations were very low and fluctuated about the Tier II groundwater AL of 0.05 mg/l (Figure C-6). Also, arsenic concentrations do not exceed the surface water AL in the seep water (see Appendix B) or in surface water at station GS03 (Walnut Creek at Indiana Street) (see below). GS03 is the Site boundary point of compliance for assessing surface water quality impacts from Site operations.

Arsenic Concentrations at GS03 (mg/l)*

Year	Min	Max	Ave
1999	0	0.003	0.002
2000	0.001	0.002	0.001
2001	0	0.002	0.001
2002	Incomplete		

*Data collected by the City of Broomfield

In summary, with the exception of arsenic, inorganic constituent concentrations in unconsolidated material groundwater were either decreasing, and thus the quality was improving, or were already at or below the surface water ALs. Although arsenic concentrations are above the surface water AL, they are near the Tier II groundwater AL, and arsenic levels are below the AL in the seep and at the Site boundary surface water point of compliance.

5.3 Radionuclides

As shown in the Appendix A summary table, gross alpha, gross beta, tritium, uranium-233,234 and uranium-238 in unconsolidated material groundwater exceeded the surface water ALs. Examination of Figures C-10 through C-14 reveals the following: gross alpha concentrations were decreasing in well 786 and were below the surface water AL in well 72293; gross beta concentrations were decreasing in well 786 but were approximately two times the surface water AL in well 72293; tritium concentrations were below the surface water AL in well 786, and generally below the surface water AL in well 72293; and uranium-233,234 and uranium-238 concentrations were above the surface water AL of 10 pCi/g (sum of the isotopes) in well 786 but below the AL in well 72293. Although the gross beta concentrations exceeded the surface water AL in well 72293, concentrations were below Site background (132 pCi/g)[1] and compliance with surface water ALs was achieved for the specific radionuclides. With respect to uranium-233,234 and uranium-238, concentrations were also below Site background (U-233,234 – 93 pCi/l); U-238 – 66 pCi/l) and the isotopic ratios were approximately 1 which suggests the uranium is natural. Also, gross beta and uranium concentrations meet the surface water ALs in the seep discharge (see Section 6). Therefore, the unconsolidated material groundwater quality data indicate that radionuclide concentrations are at or near surface water ALs or are otherwise below background concentrations; and in the latter case, have no apparent impact on seep water quality.

6. ASSESSMENT OF LANDFILL SEEP WATER QUALITY

Water discharges from the east face of the landfill upgradient of the East Landfill Pond and has been monitored at surface water station SW097. A passive aeration treatment system is in place to remove volatile organic compounds (VOCs) present in the seepage. Samples were collected from SW097 through 1995, and then discontinued with the start of sampling of the treatment system surface water stations. The influent, system midpoint, and effluent at the treatment system are monitored at surface water stations SW00396, SW00296, and SW00196, respectively.

6.1 Organics

As shown in the Appendix B summary table, there are many organic compounds that have been detected in the seep water. However, only benzene, bis(2-ethylhexyl)phthalate, chloroethane, methylene chloride, naphthalene, tetrachloroethene, trichloroethene, and vinyl chloride exceeded the surface water ALs.

At stations SW00196, SW00296, and SW00396, benzene concentrations fluctuate about the surface water AL, and the more recent data for chloroethane, methylene chloride, naphthalene, and vinyl chloride indicate concentrations are below the surface water ALs (see Figure D-1, and Figures D-3 through D-6). Data collected over the past year at SW00196 indicate that the concentrations of these latter compounds continue to be below their respective surface water ALs (data resides in the soil water database (SWD)). Although chloroethane, methylene chloride and vinyl chloride concentrations have been higher at SW097, the more recent data for the treatment system monitoring stations is more representative of the current condition.

With respect to benzene, because the benzene surface water standard (0.0012 mg/l) is near the PQL (0.001 mg/l), the random fluctuations of the concentrations about the surface water AL is to be expected from a measurement sensitivity perspective. As shown below, the data for this past year at SW00196 indicate that the concentrations continue to fluctuate about the surface water AL.

[1] Background levels for streams, seeps, and the Upper Hydrostratigraphic Unit groundwater are the mean plus two standard deviations of the Site background concentrations as reported in the Background Geochemical Characterization Report (DOE 1993).

Current Benzene Concentrations at SW00196 (mg/l)

Sample Date	Concentrations
6/18/02	0.00094
12/5/02	**0.0016**
1/7/03	**0.0013**
2/6/03	0.001
3/12/03	0.0012

Bold face indicates surface water AL was exceeded.

With respect to bis(2-ethylhexyl)phthalate, this compound was below the surface water AL at SW097 and SW00296, and near or below the surface water AL at SW00396 (see Figure D-2). Except for two apparent outliers (relative to all the other data for these stations), the concentrations of bis(2-ethylhexyl)phthalate were also at or below the surface water AL at SW00196. The two data points are considered outliers because the relatively high concentrations were not observed in the influent to the treatement system (SW00396). The last three measurements at station SW00196 were below the AL.

Tetrachloroethene and trichloroethene concentrations were not plotted because there was only one exceedance of the surface water ALs for each compound, and each exceedance was at SW097 and was just above the ALs (see Appendix B). The data for these compounds at the treatment system stations (SW00196, SW00296, and SW00396) indicate that concentrations are below their respective surface water ALs.

In summary, the organic compound data for the treatment system stations indicates that organic detections are at low concentrations that are near or below the surface water ALs.

6.2 Inorganics

As shown in the Appendix B summary table, aluminum, antimony, barium, beryllium, cadmium, copper, lead, mercury, silver, and zinc exceeded the surface water ALs in the seep water, primarily at SW097 (see Figures D-7 through D-16). However, with the exception of barium and zinc, all of these metals were at concentrations (with rare exceptions) that were below the surface water ALs at SW00196, which represent the most recent data for all of the surface water stations in the vicinity of the seep. It is likely that the lower concentrations of metals observed at SW00196 relative to SW097 is a result of the sampling technique that was used at this station. MAN-121-OU7, *Sampling and Analysis Plan for OU7 Passive Aeration System*, presents a sampling technique that is designed to limit the amount of suspended solids in the sample. The sampling technique was established because of the high concentrations of suspended solids in the water, which is largely due to the obvious iron precipitation that is occurring (red suspended material and staining of the local rock).

Barium and zinc were present at SW00196 at concentrations just above their respective surface water ALs (Figures D-9 and D-16). Barium was detected at concentrations between 0.5 and 1 mg/l. Although the surface water standard is 0.49 mg/l, these concentrations are below the Preliminary Remediation Goal (PRG)[2] of 2.56 mg/l and below the Safe Drinking Water Act Maximum Contaminant Level (MCL) of 2 mg/l. The concentrations are also below Site background (4.3 mg/l). Zinc was detected at concentrations above the surface water standard (0.183 mg/l) in the range of 0.189 and 0.287 mg/l; however, these concentrations are well below the PRG of 11 mg/l (there is no MCL for zinc) and below Site background (1.06 mg/l) Also, as shown below, downgradient surface water quality at station GS03 (the Site boundary point of compliance) meets the barium and zinc surface water ALs.

Barium and Zinc Concentrations at GS03 (mg/l)*

	Barium			Zinc		
Year	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**

[2] Appendix N of RFCA Appendix 3, the *Implementation Guidance Document*

1999	0.049	0.120	0.078	0.005	0.096	0.023
2000	0.022	0.095	0.060	<0.0003	0.020	0.006
2001	0.016	0.094	0.057	0	0.029	0.012
2002	Incomplete					

*Data collected by the City of Broomfield

In summary, with the exception of barium and zinc, the treatment system surface water quality data indicate that the inorganic constituents are in compliance with the surface water ALs. However, barium and zinc are below their respective PRGs and Site background concentrations at the seep, and are below their respective ALs at the Site boundary surface water point of compliance.

6.3 Radionuclides

Gross alpha, gross beta, plutonium-239, radium-226, radium-228, and tritium were detected at least once above the ALs at SW097(see the Appendix B table). However, in all cases, the concentration time series presented in Appendix D (Figures D-17 through D-22) show that the most recent concentrations of these radionuclides at this station were below the surface water ALs. Also, the concentrations of radionuclides are below the surface water ALs at SW00196, which reflects the most recent data for the seep. Therefore, it is concluded that radionuclide concentrations at the seep are in compliance with the surface water ALs.

7. REFERENCES

DOE 1993, *Background Geochemical Characterization Report,* Golden, CO, September.

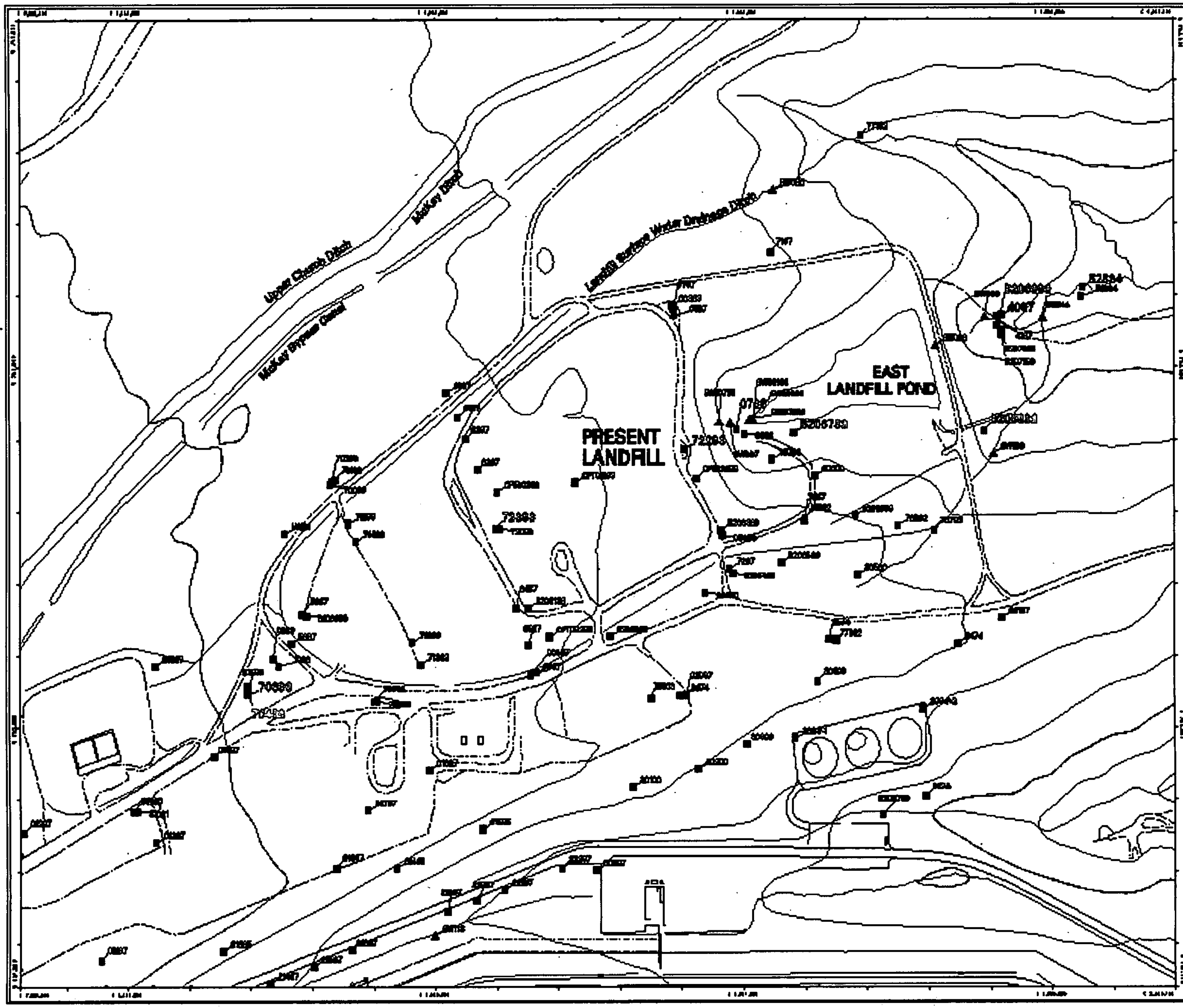


Figure 1

Locations of Wells and Surface Water Sampling Stations in the Present Landfill Area

EXPLANATION

■ Well Location

▲ Surface Water Sampling Station

Lakes and ponds

Streams, ditches, or other drainage features

Fences and other barriers

Topographic Contour (20-Foot)

Paved roads

Dirt roads

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: CH2M HILL

Prepared for: K-H

Figure 2
Sulfate Concentrations in Unconsolidated Material Groundwater

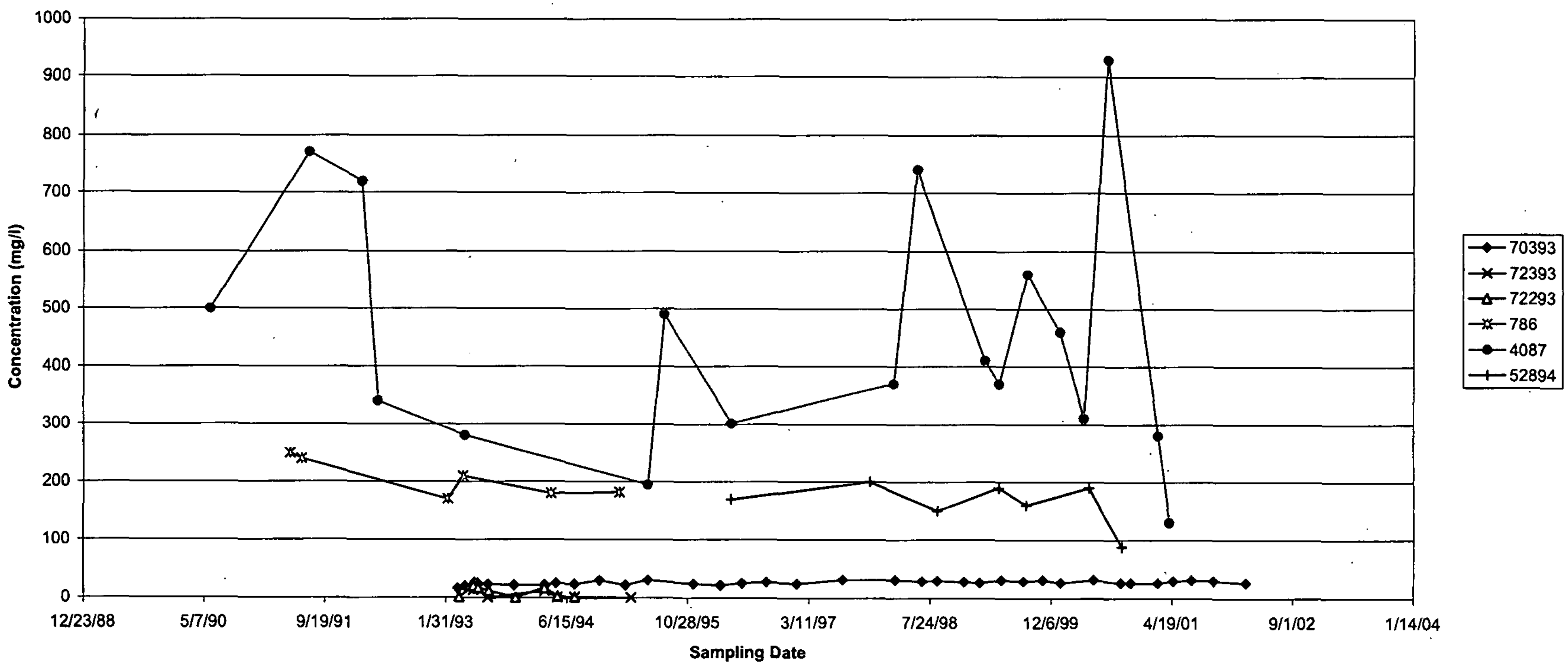


Figure 3
Sulfate Concentrations in UHSU Bedrock Groundwater

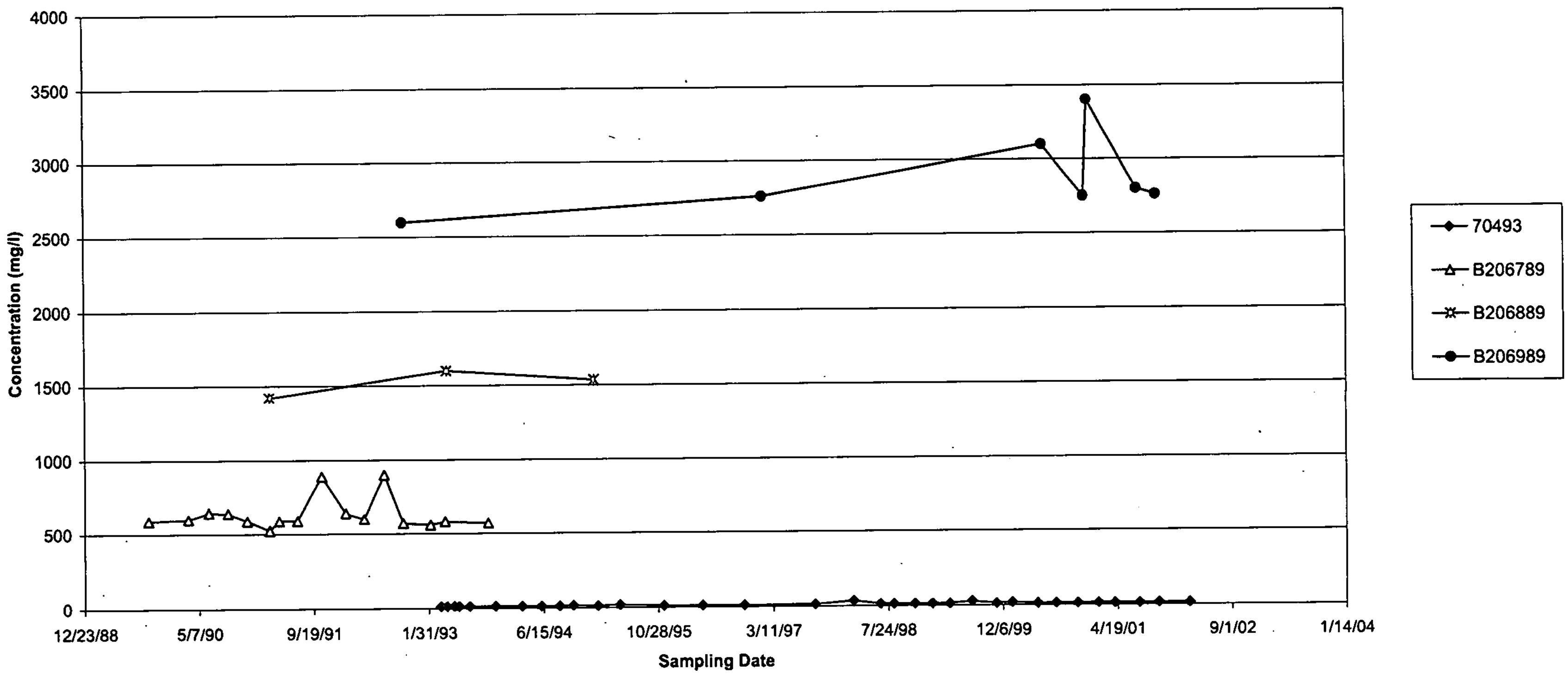


Figure 4
Nitrate Concentrations in Unconsolidated Material Groundwater

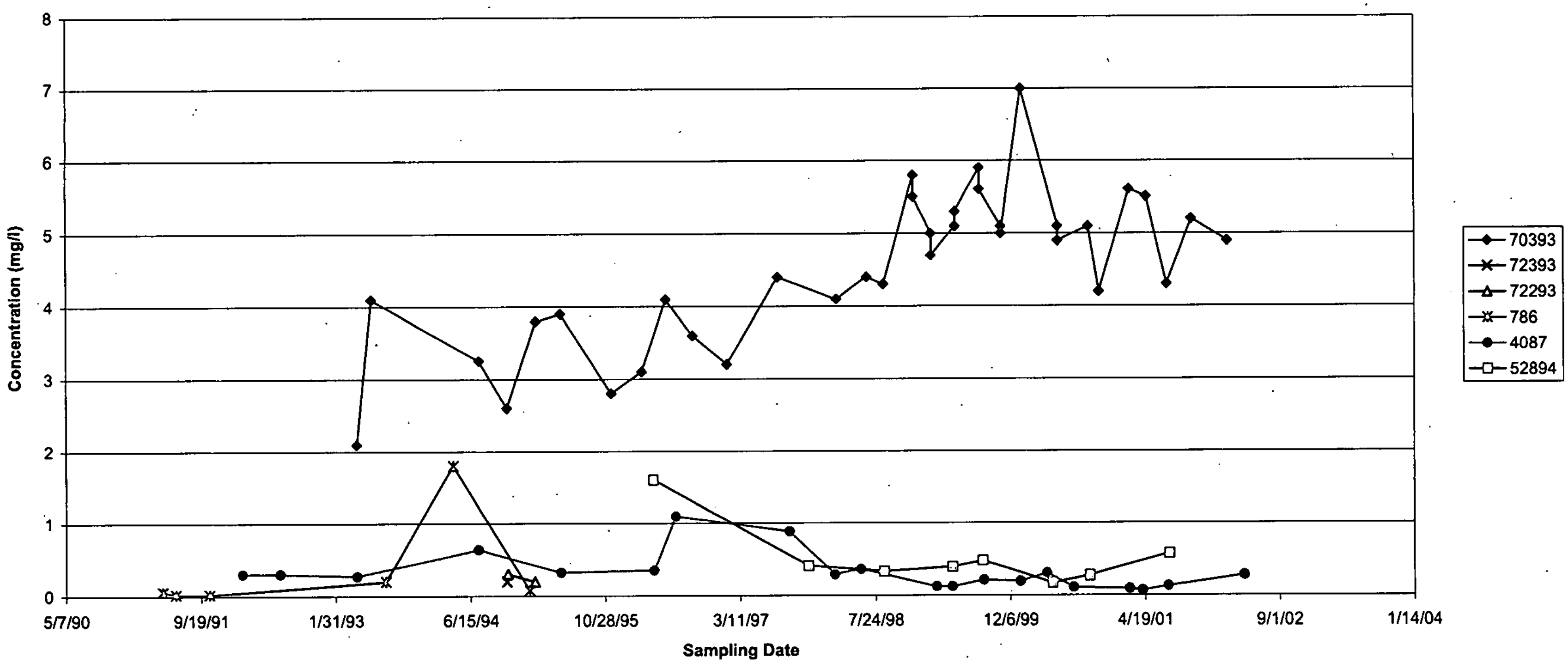


Figure 5
Nitrate Concentrations in UHSU Bedrock Groundwater

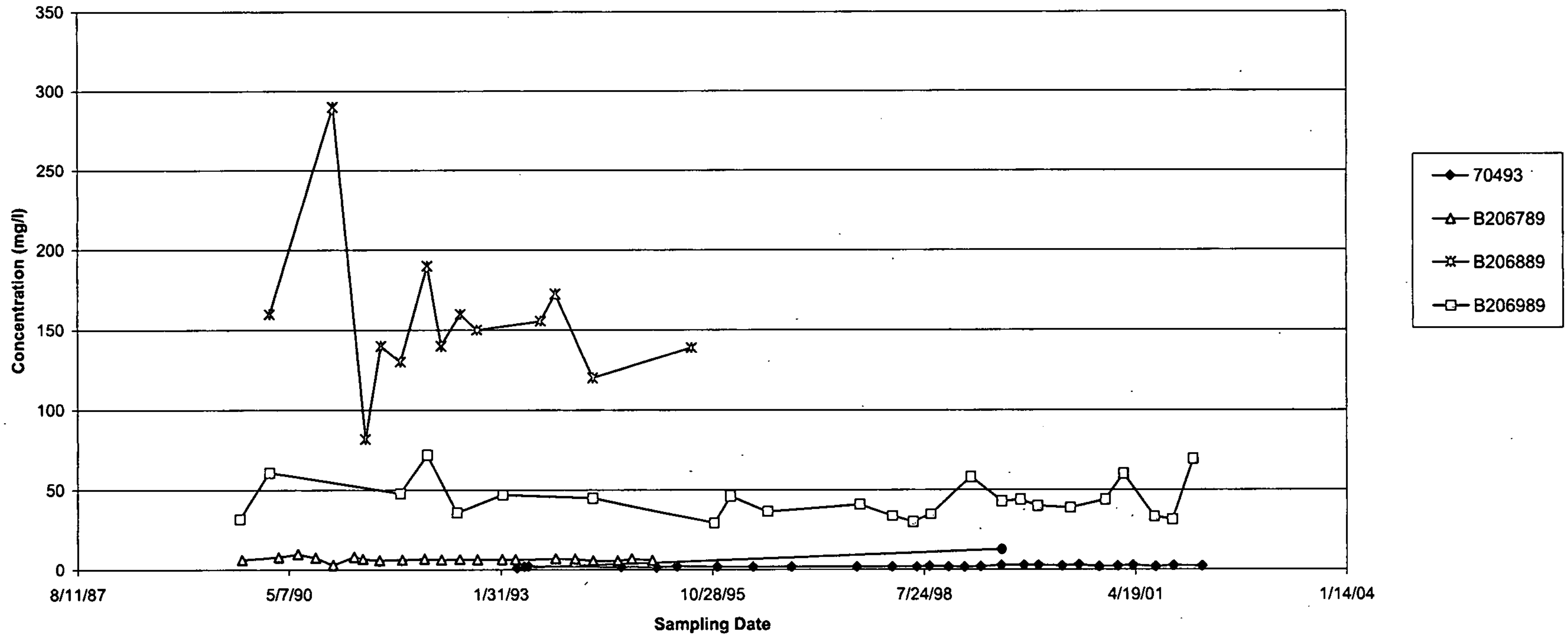


Figure 6
Chloride Concentrations in Unconsolidated Material Groundwater

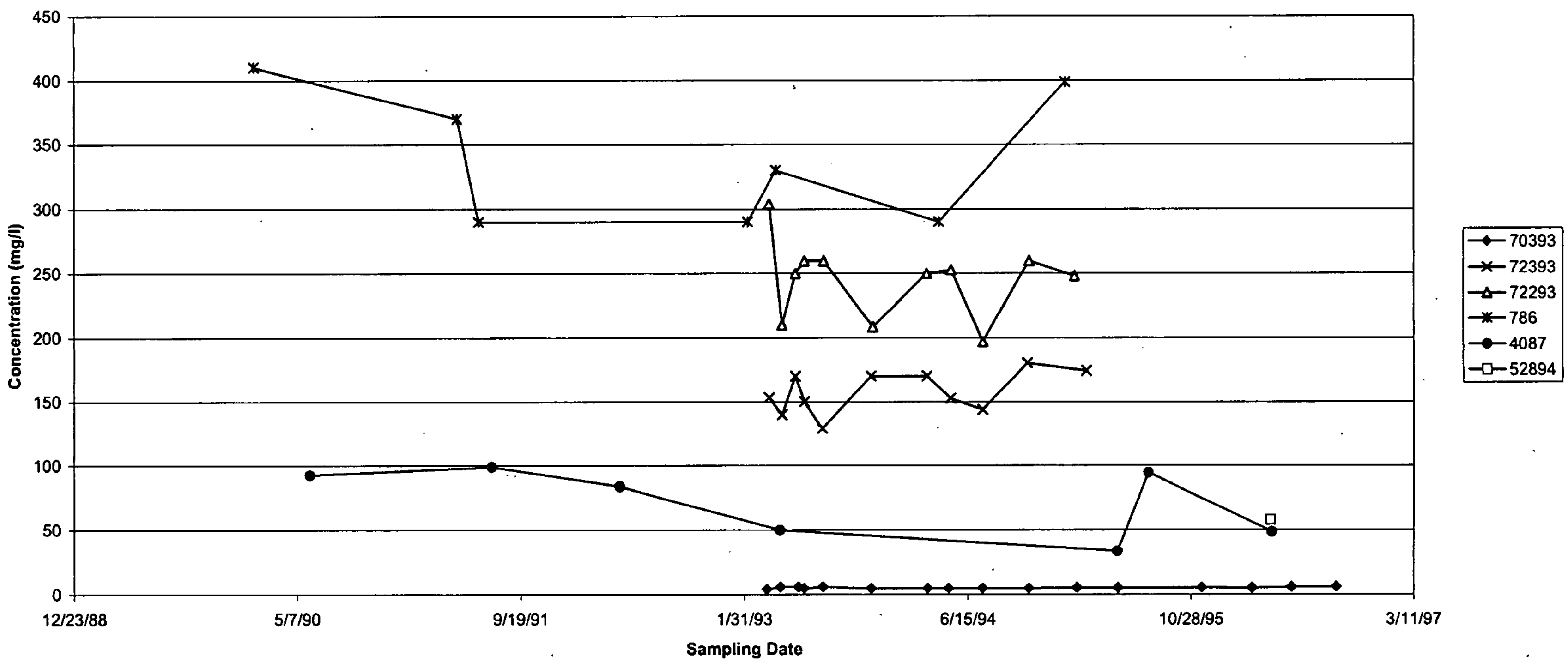


Figure 7
Chloride Concentrations in UHSU Bedrock Groundwater

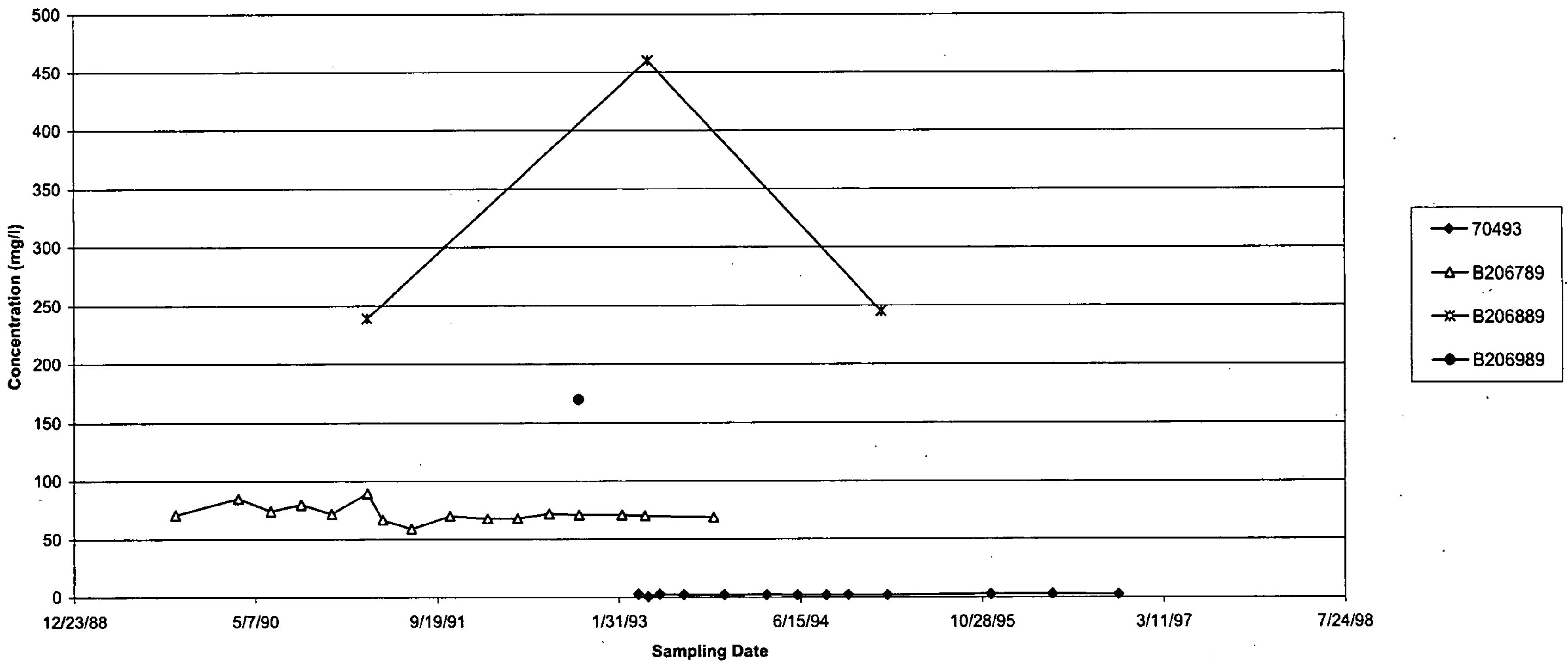


Figure 8
COD Concentrations in Unconsolidated Material Groundwater

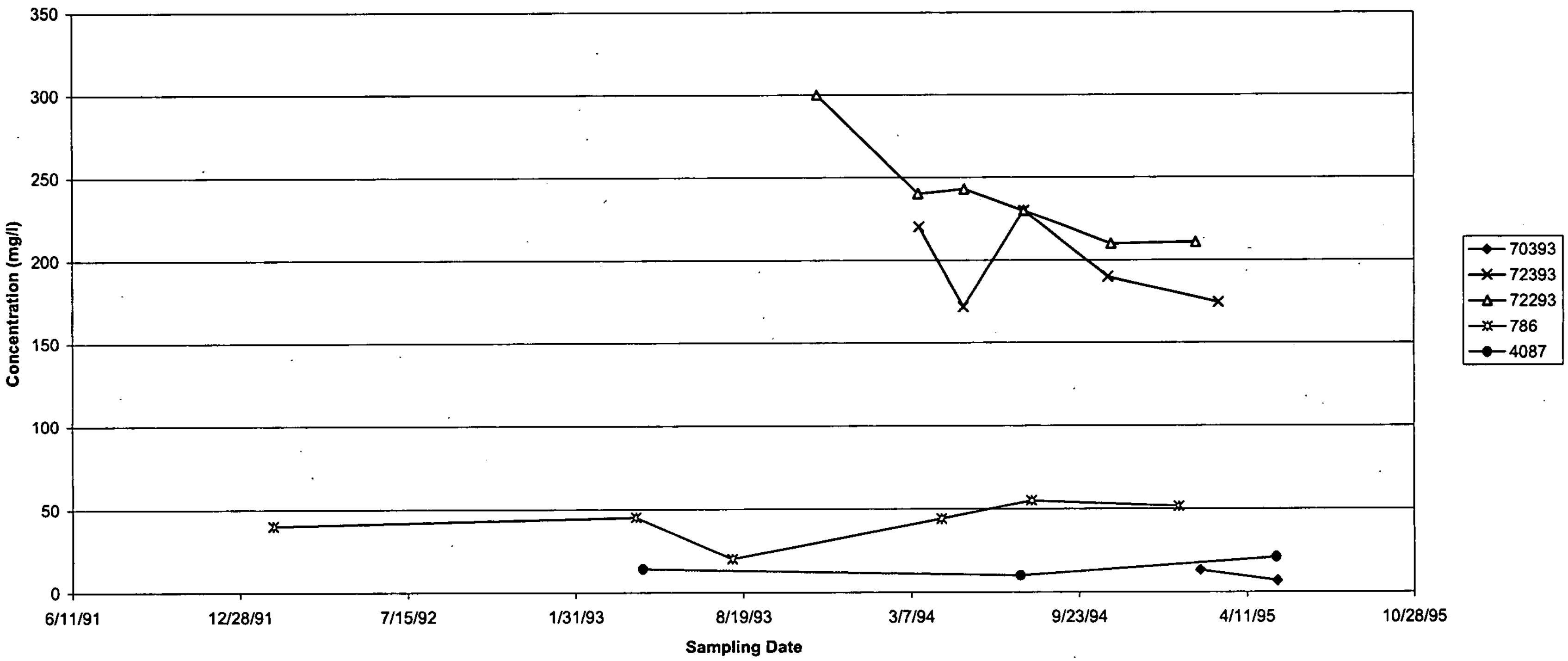
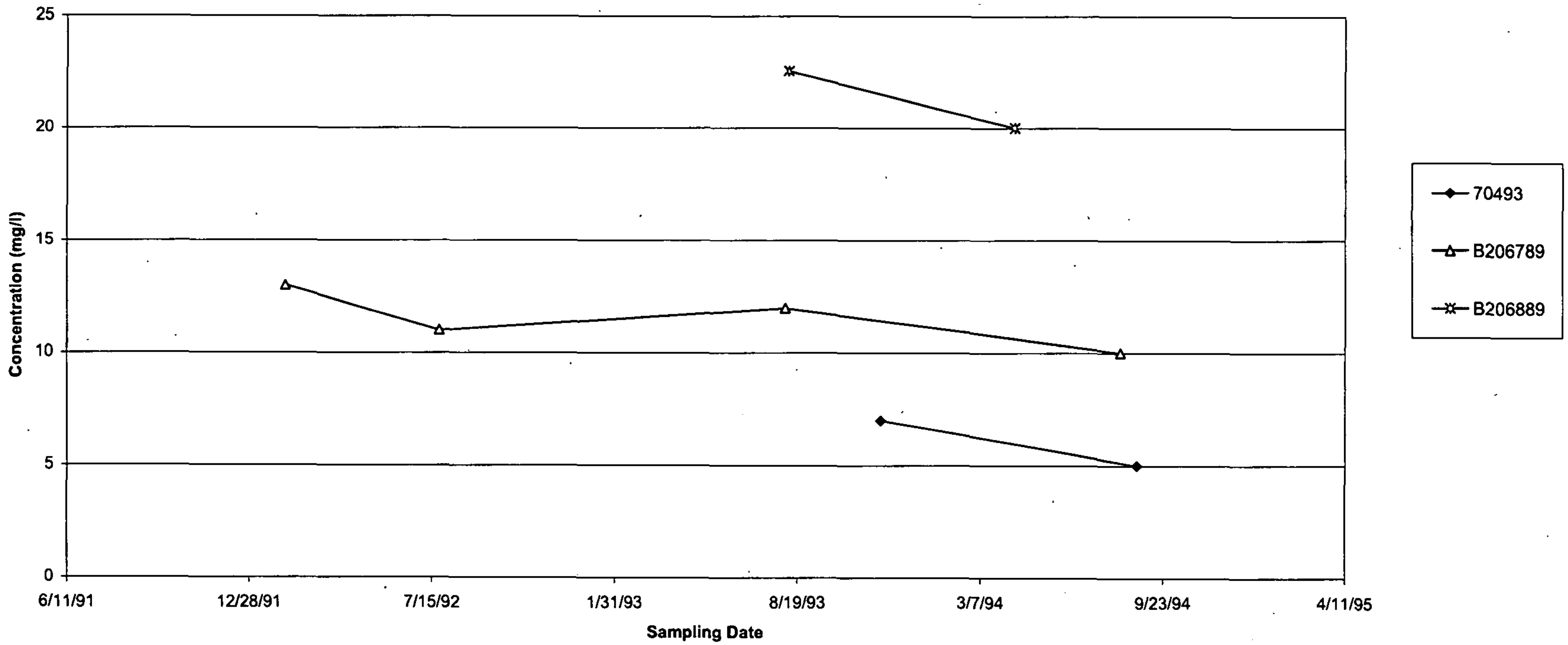


Figure 9
COD Concentrations in UHSU Bedrock Groundwater



APPENDIX A
GROUNDWATER QUALITY DATA SUMMARIES

Organic Detections in Unconsolidated Material Groundwater Within and Immediately Downgradient of the Landfill							
Well	Compound	Sample Date	Result (mg/l)	Qualifier	Tier II (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
72293	1,1,1-TRICHLOROETHANE	11/1/94	0.0002		0.2	0.2	
786	1,1-DICHLOROETHANE	4/12/94	0.0003		3.65	3.65	
72293	1,2-DICHLOROETHENE	4/27/93	0.009		0.07	0.07	
72293	1,2-DICHLOROETHENE	6/16/93	0.003	J	0.07	0.07	
72293	2,4-DIMETHYLPHENOL	5/27/93	0.007	J	0.73	0.14	
786	2-BUTANONE	12/14/89	0.09	J	21.9	21.9	
786	2-BUTANONE	1/31/90	0.54		21.9	21.9	
72293	2-BUTANONE	3/29/93	0.14		21.9	21.9	
72293	2-BUTANONE	4/27/93	0.59	E	21.9	21.9	
72293	2-BUTANONE	5/27/93	1.3		21.9	21.9	
72293	2-BUTANONE	6/16/93	0.52	E	21.9	21.9	
72293	2-BUTANONE	7/29/93	0.12	D	21.9	21.9	
72293	2-BUTANONE	7/29/93	0.12	X	21.9	21.9	
72293	2-CHLORONAPHTHALENE	5/27/93	0.005	J	2.92	0.56	
72293	2-METHYLPHENOL	5/27/93	0.014		1.83	1.83	
72293	2-METHYLPHENOL	7/29/93	0.01		1.83	1.83	
72293	4-METHYLPHENOL	3/29/93	0.031		0.183	NS	
72293	4-METHYLPHENOL	5/27/93	**2.1**	E	**0.183**	NS	
72293	4-METHYLPHENOL	6/16/93	**1.9**		**0.183**	NS	
72293	4-METHYLPHENOL	11/16/93	0.015		0.183	NS	
72293	ACENAPHTHENE	3/29/93	0.002	J	2.19	0.42	
72293	ACENAPHTHENE	4/27/93	0.003	J	2.19	0.42	
72293	ACENAPHTHENE	5/10/94	0.001	J	2.19	0.42	
72293	ACETONE	3/29/93	0.18	B	3.65	3.65	
72293	ACETONE	5/27/93	0.99		3.65	3.65	
72293	ACETONE	6/16/93	0.59	E	3.65	3.65	
72293	ACETONE	7/29/93	0.15		3.65	3.65	
72293	ACETONE	5/10/94	0.009	J	3.65	3.65	
72293	AROCLOR-1232	7/20/94	0.001		0.001	NS	
72293	BENZENE	3/29/93	**0.004**	J	0.005	**0.0012**	
72293	BENZENE	4/27/93	**0.004**	J	0.005	**0.0012**	
72293	BENZENE	7/29/93	**0.002**	J	0.005	**0.0012**	
72293	BENZENE	3/16/94	0.001	J	0.005	0.0012	
72293	BENZENE	11/1/94	0.0006		0.005	0.0012	
72293	BENZENE	2/10/95	0.0008		0.005	0.0012	
72293	BENZOIC ACID	3/29/93	0.18		146	NS	
72293	BENZOIC ACID	5/27/93	0.061		146	NS	
72293	BENZOIC ACID	6/16/93	0.97		146	NS	
72293	BENZOIC ACID	11/16/93	0.03	J	146	NS	
72293	BIS(2-ETHYLHEXYL)PHTHALATE	4/27/93	**0.011**		**0.01**	**0.01**	PQL
72293	CHLOROBENZENE	11/1/94	0.0005		0.1	0.1	
786	CHLOROETHANE	2/9/93	0.002	J	0.0294	0.0294	
786	CHLOROETHANE	10/12/93	0.003	J	0.0294	0.0294	
786	CHLOROETHANE	1/20/95	0.00057		0.0294	0.0294	
72293	CHLOROETHANE	3/29/93	**0.083**		**0.0294**	**0.0294**	
72293	CHLOROETHANE	4/27/93	**0.066**		**0.0294**	**0.0294**	
72293	CHLOROETHANE	5/27/93	**0.04**	J	**0.0294**	**0.0294**	
72293	CHLOROETHANE	6/16/93	**0.031**		**0.0294**	**0.0294**	
72293	CHLOROETHANE	7/29/93	0.025		0.0294	0.0294	
72293	CHLOROETHANE	11/16/93	0.022		0.0294	0.0294	
72293	CHLOROETHANE	3/16/94	0.016		0.0294	0.0294	
72293	CHLOROETHANE	5/10/94	0.025		0.0294	0.0294	
72293	CHLOROETHANE	11/1/94	0.008		0.0294	0.0294	
72293	CHLOROETHANE	2/10/95	0.012		0.0294	0.0294	
72293	CHLOROFORM	11/1/94	0.0001	J	0.1	0.0057	
72293	DIETHYL PHTHALATE	4/27/93	0.018		29.2	5.6	
72293	DIETHYL PHTHALATE	5/27/93	0.047		29.2	5.6	
72293	DIETHYL PHTHALATE	6/16/93	0.04	J	29.2	5.6	
72293	DIETHYL PHTHALATE	11/16/93	0.008	J	29.2	5.6	
72293	DIETHYL PHTHALATE	3/16/94	0.003	J	29.2	5.6	
72293	DIETHYL PHTHALATE	5/10/94	0.002	J	29.2	5.6	
72293	DIETHYL PHTHALATE	7/20/94	0.005	J	29.2	5.6	
72293	DIMETHYL PHTHALATE	5/10/94	0.002	J	365	313	
72293	DI-N-BUTYL PHTHALATE	5/27/93	0.002	J	3.65	3.65	
72293	DI-N-BUTYL PHTHALATE	5/10/94	0.003	J	3.65	3.65	
72293	ETHYLBENZENE	3/29/93	0.021		0.7	0.7	

Well	Compound	Sample Date	Result (mg/l)	Qualifier	Tier II (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
72293	ETHYLBENZENE	4/27/93	0.023		0.7	0.7	
72293	ETHYLBENZENE	6/16/93	0.008		0.7	0.7	
72293	ETHYLBENZENE	7/29/93	0.008		0.7	0.7	
72293	ETHYLBENZENE	11/16/93	0.009	J	0.7	0.7	
72293	ETHYLBENZENE	3/16/94	0.008		0.7	0.7	
72293	ETHYLBENZENE	5/10/94	0.013		0.7	0.7	
72293	ETHYLBENZENE	7/20/94	0.011		0.7	0.7	
72293	ETHYLBENZENE	11/1/94	0.0004		0.7	0.7	
72293	ETHYLBENZENE	2/10/95	0.0005		0.7	0.7	
72293	FLUORENE	3/29/93	0.002	J	1.46	0.28	
72293	FLUORENE	3/16/94	0.002	J	1.46	0.28	
72293	FLUORENE	5/10/94	0.001	J	1.46	0.28	
786	METHYLENE CHLORIDE	12/14/89	0.004	J	0.005	0.0047	PQL
786	METHYLENE CHLORIDE	5/1/91	0.002	BJ	0.005	0.0047	PQL
786	METHYLENE CHLORIDE	8/6/93	0.001	J	0.005	0.0047	PQL
786	METHYLENE CHLORIDE	10/12/93	0.003	J	0.005	0.0047	PQL
786	METHYLENE CHLORIDE	4/12/94	0.0004		0.005	0.0047	PQL
786	METHYLENE CHLORIDE	7/28/94	0.002	J	0.005	0.0047	PQL
72293	METHYLENE CHLORIDE	6/16/93	0.004	J	0.005	0.0047	PQL
72293	METHYLENE CHLORIDE	11/1/94	0.003		0.005	0.0047	PQL
72293	NAPHTHALENE	3/29/93	0.013		1.46	0.028	
72293	NAPHTHALENE	7/29/93	**0.031**		1.46	**0.028**	
72293	NAPHTHALENE	11/16/93	0.005	J	1.46	0.028	
72293	NAPHTHALENE	3/16/94	0.006	J	1.46	0.028	
72293	NAPHTHALENE	5/10/94	0.005	J	1.46	0.028	
72293	NAPHTHALENE	7/20/94	0.004	J	1.46	0.028	
72293	PENTACHLOROPHENOL	5/27/93	0.004	J	0.05	0.05	PQL
72293	PHENANTHRENE	3/29/93	2.00E-03	J		0.01	PQL
72293	PHENANTHRENE	4/27/93	2.00E-03	J		0.01	PQL
72293	PHENANTHRENE	3/16/94	2.00E-03	J		0.01	PQL
72293	PHENANTHRENE	5/10/94	1.00E-03	D		0.01	PQL
72293	PHENOL	3/29/93	0.016		21.9	2.56	
72293	PHENOL	5/27/93	0.083		21.9	2.56	
72293	PHENOL	6/16/93	0.13		21.9	2.56	
72293	PHENOL	7/29/93	0.051		21.9	2.56	
72293	TETRACHLOROETHENE	11/1/94	0.0008		0.005	0.001	PQL
72293	TOLUENE	3/29/93	0.1		1	1	
72293	TOLUENE	4/27/93	0.39	E	1	1	
72293	TOLUENE	5/27/93	0.58		1	1	
72293	TOLUENE	6/16/93	**1.2**	E	**1**	**1**	
72293	TOLUENE	7/29/93	0.39	E	1	1	
72293	TOLUENE	11/16/93	0.015		1	1	
72293	TOLUENE	3/16/94	0.008		1	1	
72293	TOLUENE	5/10/94	0.008	J	1	1	
72293	TOLUENE	7/20/94	0.006		1	1	
72293	TOLUENE	11/1/94	0.0007		1	1	
72293	TOLUENE	2/10/95	0.0003	J	1	1	
72293	TRICHLOROETHENE	4/27/93	**0.004**	J	0.005	**0.0027**	
72293	VINYL CHLORIDE	6/16/93	**0.009**	J	**0.002**	**0.002**	PQL
72293	VINYL CHLORIDE	7/29/93	**0.008**	J	**0.002**	**0.002**	PQL
72293	XYLENES, TOTAL	3/29/93	0.11		10	10	
72293	XYLENES, TOTAL	4/27/93	0.12		10	10	
72293	XYLENES, TOTAL	5/27/93	0.03	JX	10	10	
72293	XYLENES, TOTAL	6/16/93	0.03	X	10	10	
72293	XYLENES, TOTAL	7/29/93	0.03	X	10	10	
72293	XYLENES, TOTAL	11/16/93	0.04		10	10	
72293	XYLENES, TOTAL	3/16/94	0.04	X	10	10	
72293	XYLENES, TOTAL	5/10/94	0.069		10	10	
72293	XYLENES, TOTAL	7/20/94	0.066		10	10	
Bold face type indicates the analyte was detected above the Surface Water Standard or the Tier II Groundwater Action Level							

Inorganic Detections in Unconsolidated Material Groundwater Within and Immediately Downgradient of the Landfill							
Well	Compound	Sample Date	Result (mg/l)	Qualifier	Tier II (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
72293	ALUMINUM	3/29/93	**4.56**		36.5	**0.087**	dissolved
72293	ALUMINUM	4/27/93	**1.07**		36.5	**0.087**	dissolved
72293	ALUMINUM	5/27/93	**0.666**		36.5	**0.087**	dissolved
72293	ALUMINUM	6/16/93	**0.29**		36.5	**0.087**	dissolved
72293	ALUMINUM	7/29/93	**0.17**	B	36.5	**0.087**	dissolved
72293	ALUMINUM	3/16/94	**0.42**	*	36.5	**0.087**	dissolved
72293	ALUMINUM	5/10/94	**0.232**		36.5	**0.087**	dissolved
72293	ALUMINUM	2/10/95	**0.14**	B	36.5	**0.087**	dissolved
72293	ARSENIC	3/29/93	0.0085		0.05	**0.005**	PQL estimated
72293	ARSENIC	4/27/93	0.03	N	0.05	**0.005**	PQL estimated
72293	ARSENIC	5/27/93	**0.0707**		**0.05**	**0.005**	PQL estimated
72293	ARSENIC	6/16/93	0.0108		0.05	**0.005**	PQL estimated
72293	ARSENIC	7/29/93	0.0117		0.05	**0.005**	PQL estimated
72293	ARSENIC	11/16/93	0.0151		0.05	**0.005**	PQL estimated
72293	ARSENIC	3/16/94	0.0326		0.05	**0.005**	PQL estimated
72293	ARSENIC	5/10/94	**0.0747**		**0.05**	**0.005**	PQL estimated
72293	ARSENIC	7/20/94	0.0347		0.05	**0.005**	PQL estimated
72293	ARSENIC	11/1/94	0.0143		0.05	**0.005**	PQL estimated
72293	ARSENIC	2/10/95	**0.0925**		**0.05**	**0.005**	PQL estimated
786	BARIUM	1/31/90	0.06	J	2	0.49	total rec
72293	BARIUM	3/29/93	0.368		2	0.49	total rec
72293	BARIUM	4/27/93	**0.726**		2	**0.49**	total rec
72293	BARIUM	5/27/93	**0.519**		2	**0.49**	total rec
72293	BARIUM	6/16/93	0.407		2	0.49	total rec
72293	BARIUM	7/29/93	0.289		2	0.49	total rec
72293	BARIUM	11/16/93	0.281		2	0.49	total rec
72293	BARIUM	3/16/94	0.245		2	0.49	total rec
72293	BARIUM	5/10/94	0.238		2	0.49	total rec
72293	BARIUM	7/20/94	0.261		2	0.49	total rec
72293	BARIUM	11/1/94	0.219		2	0.49	total rec
72293	BARIUM	2/10/95	0.237		2	0.49	total rec
72293	BERYLLIUM	4/27/93	0.0015		0.005	0.005	PQL
72293	CADMIUM	4/27/93	0.0028		0.005	0.005	PQL dissolved
72293	CADMIUM	5/27/93	0.0138		0.005	0.005	PQL dissolved
72293	CADMIUM	2/10/95	0.0021	B	0.005	0.005	PQL dissolved
72293	CHROMIUM	5/10/94	0.006	B	0.1	0.05	total rec
786	COBALT	1/31/90	0.01	J	2.19	NS	
72293	COBALT	3/29/93	0.0054		2.19	NS	
72293	COBALT	3/29/93	0.0076		2.19	NS	
72293	COBALT	4/27/93	0.0162		2.19	NS	
72293	COBALT	5/27/93	0.01	B	2.19	NS	
72293	COBALT	6/16/93	0.009	B	2.19	NS	
72293	COBALT	7/29/93	0.0066	B	2.19	NS	
72293	COBALT	2/10/95	0.0047	B	2.19	NS	
72293	COPPER	3/29/93	0.0047		1.3	0.016	
72293	COPPER	4/27/93	0.0045		1.3	0.016	
72293	COPPER	5/27/93	0.0054	B	1.3	0.016	
72293	COPPER	6/16/93	0.0055	B	1.3	0.016	
72293	COPPER	7/29/93	0.0035	B	1.3	0.016	
72293	COPPER	11/16/93	0.0051	B	1.3	0.016	
72293	COPPER	3/16/94	0.0036	B	1.3	0.016	
72293	COPPER	5/10/94	0.0092	B	1.3	0.016	
72293	COPPER	2/10/95	0.004	B	1.3	0.016	
786	FLUORIDE	1/31/90	1.1		4	2	
786	FLUORIDE	5/1/91	1.6		4	2	
786	FLUORIDE	6/18/91	1.5		4	2	
786	FLUORIDE	2/9/93	1.2		4	2	
786	FLUORIDE	4/13/93	1.5		4	2	
786	FLUORIDE	4/12/94	1.9		4	2	

Well	Compound	Sample Date	Result (mg/l)	Qualifier	Tier II (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
786	FLUORIDE	1/20/95	1.139		4	2	
72293	FLUORIDE	3/29/93	7		**4**	**2**	
72293	FLUORIDE	4/27/93	0.68		4	2	
72293	FLUORIDE	5/27/93	0.9		4	2	
72293	FLUORIDE	6/16/93	0.9		4	2	
72293	FLUORIDE	7/29/93	1.1		4	2	
72293	FLUORIDE	11/16/93	1.03		4	2	
72293	FLUORIDE	3/16/94	1.2		4	2	
72293	FLUORIDE	5/10/94	1.04		4	2	
72293	FLUORIDE	7/20/94	1.22		4	2	
72293	FLUORIDE	11/1/94	1		4	2	
72293	FLUORIDE	2/10/95	1.2		4	2	
786	IRON	1/31/90	3.76		NS	NS	
72293	IRON	3/29/93	50.9		NS	NS	
72293	IRON	4/27/93	150		NS	NS	
72293	IRON	5/27/93	77.8		NS	NS	
72293	IRON	6/16/93	68.2		NS	NS	
72293	IRON	7/29/93	41		NS	NS	
72293	IRON	11/16/93	40.4		NS	NS	
72293	IRON	3/16/94	36.4		NS	NS	
72293	IRON	5/10/94	36.6		NS	NS	
72293	IRON	11/1/94	31.7		NS	NS	
72293	IRON	2/10/95	35.2		NS	NS	
72293	LEAD	3/29/93	0.0112		0.015	**0.01**	PQL dissolved
72293	LEAD	4/27/93	0.0054		0.015	0.01	PQL dissolved
72293	LEAD	6/16/93	0.001	BW	0.015	0.01	PQL dissolved
72293	LEAD	7/29/93	0.0014	B	0.015	0.01	PQL dissolved
72293	LEAD	2/10/95	0.0014	B	0.015	0.01	PQL dissolved
72293	LITHIUM	3/29/93	0.0641		0.73	NS	
72293	LITHIUM	4/27/93	0.0668		0.73	NS	
72293	LITHIUM	5/27/93	0.06	B	0.73	NS	
72293	LITHIUM	6/16/93	0.06	B	0.73	NS	
72293	LITHIUM	7/29/93	0.05	B	0.73	NS	
72293	LITHIUM	11/16/93	0.06	B	0.73	NS	
72293	LITHIUM	3/16/94	0.06	B	0.73	NS	
72293	LITHIUM	5/10/94	0.05	B	0.73	NS	
72293	LITHIUM	11/1/94	0.05	B	0.73	NS	
72293	LITHIUM	2/10/95	0.06	B	0.73	NS	
786	MANGANESE	1/31/90	0.648		1.72	NS	
72293	MANGANESE	3/29/93	2.13		**1.72**	NS	
72293	MANGANESE	4/27/93	8.32		**1.72**	NS	
72293	MANGANESE	5/27/93	3.88		**1.72**	NS	
72293	MANGANESE	6/16/93	2.71		**1.72**	NS	
72293	MANGANESE	7/29/93	1.62		1.72	NS	
72293	MANGANESE	11/16/93	1.46		1.72	NS	
72293	MANGANESE	3/16/94	1.31		1.72	NS	
72293	MANGANESE	5/10/94	1.27		1.72	NS	
72293	MANGANESE	11/1/94	1.18		1.72	NS	
72293	MANGANESE	2/10/95	1.17		1.72	NS	
72293	MERCURY	6/16/93	0.0015		0.002	0.001	PQL total
72293	MOLYBDENUM	4/27/93	0.0124		0.183	NS	
72293	MOLYBDENUM	11/16/93	0.02	B	0.183	NS	
786	NICKEL	1/31/90	**0.795**		**0.14**	**0.123**	dissolved
72293	NICKEL	4/27/93	0.0211		0.14	0.123	dissolved
72293	NICKEL	5/27/93	0.01	B	0.14	0.123	dissolved
72293	NICKEL	6/16/93	0.02	B	0.14	0.123	dissolved
72293	NICKEL	7/29/93	0.02	B	0.14	0.123	dissolved
72293	NICKEL	3/16/94	0.01	B	0.14	0.123	dissolved
72293	NICKEL	5/10/94	0.01	B	0.14	0.123	dissolved
72293	NICKEL	7/20/94	0.01	B	0.14	0.123	dissolved

Well	Compound	Sample Date	Result (mg/l)	Qualifier	Tier II (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
72293	NICKEL	11/1/94	0.0098	B	0.14	0.123	dissolved
72293	NICKEL	2/10/95	0.0097	B	0.14	0.123	dissolved
786	NITRATE/NITRITE	5/1/91	0.06		10	10	
786	NITRATE/NITRITE	6/18/91	0.02		10	10	
786	NITRATE/NITRITE	10/21/91	0.02		10	10	
786	NITRATE/NITRITE	8/6/93	0.2		10	10	
786	NITRATE/NITRITE	4/12/94	1.8		10	10	
786	NITRATE/NITRITE	1/20/95	0.08	B	10	10	
72293	NITRATE/NITRITE	11/1/94	0.3		10	10	
72293	NITRATE/NITRITE	2/10/95	0.2		10	10	
786	SELENIUM	1/31/90	0.0022	J	0.05	0.01	PQL
786	STRONTIUM	1/31/90	2.56		21.9	NS	
72293	STRONTIUM	3/29/93	1.96		21.9	NS	
72293	STRONTIUM	4/27/93	3.71		21.9	NS	
72293	STRONTIUM	5/27/93	3.03		21.9	NS	
72293	STRONTIUM	6/16/93	2.57		21.9	NS	
72293	STRONTIUM	7/29/93	2.2		21.9	NS	
72293	STRONTIUM	11/16/93	2.3		21.9	NS	
72293	STRONTIUM	3/16/94	2		21.9	NS	
72293	STRONTIUM	5/10/94	1.93		21.9	NS	
72293	STRONTIUM	11/1/94	1.79		21.9	NS	
72293	STRONTIUM	2/10/95	1.74		21.9	NS	
786	SULFATE	1/31/90	380		500	NS	
786	SULFATE	5/1/91	250		500	NS	
786	SULFATE	6/18/91	240		500	NS	
786	SULFATE	2/9/93	170		500	NS	
786	SULFATE	4/13/93	210		500	NS	
786	SULFATE	4/12/94	180		500	NS	
786	SULFATE	1/20/95	181.974		500	NS	
72293	SULFATE	3/29/93	1.7		500	NS	
72293	SULFATE	5/27/93	21		500	NS	
72293	SULFATE	6/16/93	18		500	NS	
72293	SULFATE	7/29/93	12		500	NS	
72293	SULFATE	11/16/93	0.62	B	500	NS	
72293	SULFATE	3/16/94	17		500	NS	
72293	SULFATE	5/10/94	2.77	B	500	NS	
72293	SULFATE	7/20/94	1.33		500	NS	
72293	SULFIDE	4/27/93	**16**		NS	**0.002**	
72293	SULFIDE	5/27/93	**7**		NS	**0.002**	
72293	SULFIDE	6/16/93	**7**		NS	**0.002**	
72293	SULFIDE	7/29/93	**5**		NS	**0.002**	
72293	SULFIDE	3/16/94	**2**		NS	**0.002**	
72293	SULFIDE	5/10/94	**1.345**		NS	**0.002**	
786	TIN	1/31/90	0.128		21.9	NS	
72293	TIN	4/27/93	0.0564		21.9	NS	
72293	TIN	11/16/93	0.09	B	21.9	NS	
72293	TIN	5/10/94	0.08	B	21.9	NS	
72293	VANADIUM	3/29/93	0.0094		0.256	NS	
72293	VANADIUM	7/29/93	0.01	B	0.256	NS	
72293	VANADIUM	11/16/93	0.02	B	0.256	NS	
72293	VANADIUM	3/16/94	0.02	B	0.256	NS	
72293	VANADIUM	5/10/94	0.02	B	0.256	NS	
72293	VANADIUM	7/20/94	0.03	B	0.256	NS	
72293	VANADIUM	11/1/94	0.0089	B	0.256	NS	
72293	VANADIUM	2/10/95	0.01	B	0.256	NS	
786	ZINC	1/31/90	0.127		11	0.141	dissolved
72293	ZINC	3/29/93	0.0736		11	0.141	dissolved
72293	ZINC	4/27/93	0.0655		11	0.141	dissolved
72293	ZINC	5/27/93	0.0273		11	0.141	dissolved
72293	ZINC	6/16/93	0.0205		11	0.141	dissolved

Well	Compound	Sample Date	Result (mg/l)	Qualifier	Tier II (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
72293	ZINC	7/29/93	0.0313		11	0.141	dissolved
72293	ZINC	11/16/93	0.0261		11	0.141	dissolved
72293	ZINC	5/10/94	0.0378		11	0.141	dissolved
72293	ZINC	7/20/94	0.01	B	11	0.141	dissolved
72293	ZINC	2/10/95	0.04	E	11	0.141	dissolved
Bold face type indicates the analyte was detected above the surface water standard or the Tier II							
Groundwater Action Level							
NS - No Standard							

Radionuclide Detections in Unconsolidated Material Groundwater Within and Immediately Downgradient of the Landfill						
Well	Radionuclide	Sample Date	Result (pCi/l)	Qualifier	Tier II (pCi/l)	SW Std. (pCi/l)
72293	AMERICIUM-241	3/29/93	0.00146	J	0.145	0.15
72293	AMERICIUM-241	4/27/93	0.03	B	0.145	0.15
72293	AMERICIUM-241	5/27/93	0.00374		0.145	0.15
72293	AMERICIUM-241	5/10/94	0.00254		0.145	0.15
72293	AMERICIUM-241	2/10/95	0.00292		0.145	0.15
786	GROSS ALPHA	1/31/90	**53.9**		NV	**11**
786	GROSS ALPHA	5/1/91	**37.74**		NV	**11**
786	GROSS ALPHA	4/12/94	**22.18**	C	NV	**11**
72293	GROSS ALPHA	3/29/93	3.23	J	NV	11
72293	GROSS ALPHA	4/27/93	5.9		NV	11
72293	GROSS ALPHA	5/27/93	0.45	J	NV	11
72293	GROSS ALPHA	6/16/93	9.9		NV	11
72293	GROSS ALPHA	5/10/94	0.66	C	NV	11
72293	GROSS ALPHA	7/20/94	2.81	J	NV	11
72293	GROSS ALPHA	2/10/95	4.62	C	NV	11
786	GROSS BETA	1/31/90	**29.4**		NV	**19**
786	GROSS BETA	4/12/94	11.54	C	NV	19
72293	GROSS BETA	3/29/93	**41.84**		NV	**19**
72293	GROSS BETA	4/27/93	**32**		NV	**19**
72293	GROSS BETA	5/27/93	**43.17**		NV	**19**
72293	GROSS BETA	6/16/93	**28**		NV	**19**
72293	GROSS BETA	7/29/93	**31**		NV	**19**
72293	GROSS BETA	11/16/93	**27**	C	NV	**19**
72293	GROSS BETA	3/16/94	**36**		NV	**19**
72293	GROSS BETA	5/10/94	**26.09**	C	NV	**19**
72293	GROSS BETA	7/20/94	**47.08**		NV	**19**
72293	GROSS BETA	2/10/95	**37.04**	C	NV	**19**
72293	PLUTONIUM-239/240	3/29/93	0.0047	J	0.151	0.15
72293	PLUTONIUM-239/240	4/27/93	0.01		0.151	0.15
72293	PLUTONIUM-239/240	5/27/93	0.00853	J	0.151	0.15
72293	PLUTONIUM-239/240	5/10/94	0.00134		0.151	0.15
72293	PLUTONIUM-239/240	2/10/95	0.00162		0.151	0.15
786	RADIUM-226	4/12/94	0.79		20	5
72293	RADIUM-226	4/27/93	1.5	B	20	5
72293	RADIUM-226	11/16/93	0.36		20	5
72293	RADIUM-226	5/10/94	0.33		20	5
72293	RADIUM-226	2/10/95	0.29		20	5
72293	STRONTIUM-89,90	4/27/93	**1**		**0.852**	8
72293	STRONTIUM-89,90	7/29/93	**3.9**		**0.852**	8
72293	STRONTIUM-89,90	5/10/94	0.25		0.852	8
72293	STRONTIUM-89,90	2/10/95	0.27		0.852	8
786	TRITIUM	1/31/90	290		20000	500
786	TRITIUM	11/6/90	266.1	J	20000	500
786	TRITIUM	5/1/91	134.2	J	20000	500
786	TRITIUM	6/18/91	368	J	20000	500
786	TRITIUM	7/17/91	239.7	J	20000	500
786	TRITIUM	10/21/91	151.4	J	20000	500
786	TRITIUM	4/13/93	172.2	J	20000	500
786	TRITIUM	10/12/93	176.77		20000	500
786	TRITIUM	1/18/94	136.59		20000	500
786	TRITIUM	1/20/95	167.55		20000	500
72293	TRITIUM	3/29/93	124.6	J	20000	500
72293	TRITIUM	4/27/93	**640**		20000	**500**
72293	TRITIUM	6/16/93	530		20000	500
72293	TRITIUM	11/16/93	400		20000	500
72293	TRITIUM	3/16/94	**880**		20000	**500**
72293	TRITIUM	5/10/94	215.49		20000	500
72293	TRITIUM	7/20/94	367.9		20000	500
72293	TRITIUM	11/1/94	469.8		20000	500
72293	TRITIUM	2/10/95	346.6		20000	500
786	URANIUM-233,-234	1/31/90	**21.97**		**1.06**	**10**
786	URANIUM-233,-234	5/1/91	**27.28**		**1.06**	**10**
786	URANIUM-233,-234	4/12/94	**22.19**		**1.06**	**10**

Well	Radionuclide	Sample Date	Result (pCi/l)	Qualifier	Tier II (pCi/l)	SW Std. (pCi/l)
72293	URANIUM-233,-234	3/29/93	0.53		1.06	10
72293	URANIUM-233,-234	4/27/93	1	B	1.06	10
72293	URANIUM-233,-234	5/27/93	0.77		1.06	10
72293	URANIUM-233,-234	6/16/93	**1.3**	B	**1.06**	10
72293	URANIUM-233,-234	7/29/93	**1.2**	B	**1.06**	10
72293	URANIUM-233,-234	11/16/93	0.56		1.06	10
72293	URANIUM-233,-234	3/16/94	0.41	J	1.06	10
72293	URANIUM-233,-234	5/10/94	**1.39**		**1.06**	10
72293	URANIUM-233,-234	7/20/94	**1.33**		**1.06**	10
72293	URANIUM-233,-234	2/10/95	0.6		1.06	10
786	URANIUM-235	1/31/90	0.8		1.01	10
786	URANIUM-235	5/1/91	0.62		1.01	10
786	URANIUM-235	4/12/94	**1.04**		**1.01**	10
72293	URANIUM-235	3/29/93	0.26	J	1.01	10
72293	URANIUM-235	4/27/93	0.12	BJ	1.01	10
72293	URANIUM-235	5/27/93	0.19	J	1.01	10
72293	URANIUM-235	5/10/94	0.07		1.01	10
72293	URANIUM-235	7/20/94	0.02	J	1.01	10
72293	URANIUM-235	2/10/95	0.3		1.01	10
786	URANIUM-238	1/31/90	**16.34**		**0.768**	**10**
786	URANIUM-238	5/1/91	**20.5**		**0.768**	**10**
786	URANIUM-238	4/12/94	**19.24**		**0.768**	**10**
72293	URANIUM-238	3/29/93	0.34	J	0.768	10
72293	URANIUM-238	4/27/93	**1**	B	**0.768**	10
72293	URANIUM-238	5/27/93	0.48		0.768	10
72293	URANIUM-238	6/16/93	0.89	B	0.768	10
72293	URANIUM-238	7/29/93	1	B	0.768	10
72293	URANIUM-238	11/16/93	0.45		0.768	10
72293	URANIUM-238	3/16/94	0.54	J	0.768	10
72293	URANIUM-238	5/10/94	0.97		0.768	10
72293	URANIUM-238	7/20/94	0.8		0.768	10
72293	URANIUM-238	2/10/95	0.3		0.768	10
Bold face type indicates the analyte was detected above the surface water standard or the Tier II						
Groundwater Action Level						
NS - No Standard						
NV - No Value						

APPENDIX B
SURFACE WATER QUALITY DATA SUMMARIES

Organic Detections in Surface Water at or Near the Seep Discharge							
Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW00196	1,1-DICHLOROETHANE	5/29/96	0.002		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	11/20/96	0.00089	J	3.65	3.65	
SW00196	1,1-DICHLOROETHANE	1/20/97	0.001		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	6/16/97	0.0042		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	10/8/97	0.002		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	11/10/97	0.0015		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	12/8/97	0.0035		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	1/15/98	0.0056		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	12/21/98	0.002		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	2/9/99	0.003		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	3/29/99	0.002		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	11/1/99	0.004		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	6/19/00	0.002		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	7/11/00	0.002		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	12/4/00	0.002		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	3/19/01	0.002		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	6/12/01	0.003		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	9/24/01	0.002		3.65	3.65	
SW00196	1,1-DICHLOROETHANE	12/3/01	0.00039	J	3.65	3.65	
SW00296	1,1-DICHLOROETHANE	9/13/96	0.005		3.65	3.65	
SW00296	1,1-DICHLOROETHANE	10/30/96	0.0062		3.65	3.65	
SW00296	1,1-DICHLOROETHANE	11/20/96	0.0054		3.65	3.65	
SW00296	1,1-DICHLOROETHANE	1/20/97	0.0055		3.65	3.65	
SW00296	1,1-DICHLOROETHANE	2/19/97	0.0054		3.65	3.65	
SW00296	1,1-DICHLOROETHANE	4/23/97	0.0045		3.65	3.65	
SW00296	1,1-DICHLOROETHANE	9/8/97	0.0027		3.65	3.65	
SW00296	1,1-DICHLOROETHANE	10/8/97	0.0044		3.65	3.65	
SW00296	1,1-DICHLOROETHANE	10/15/97	0.003		3.65	3.65	
SW00296	1,1-DICHLOROETHANE	11/10/97	0.005		3.65	3.65	
SW00296	1,1-DICHLOROETHANE	12/8/97	0.0068		3.65	3.65	
SW00296	1,1-DICHLOROETHANE	1/15/98	0.0077		3.65	3.65	
SW00396	1,1-DICHLOROETHANE	8/13/97	0.004		3.65	3.65	
SW00396	1,1-DICHLOROETHANE	9/8/97	0.0039		3.65	3.65	
SW00396	1,1-DICHLOROETHANE	10/8/97	0.0054		3.65	3.65	
SW00396	1,1-DICHLOROETHANE	10/15/97	0.0048		3.65	3.65	
SW00396	1,1-DICHLOROETHANE	11/10/97	0.0056		3.65	3.65	
SW00396	1,1-DICHLOROETHANE	12/8/97	0.0056		3.65	3.65	
SW00396	1,1-DICHLOROETHANE	1/15/98	0.0069		3.65	3.65	
SW00396	1,1-DICHLOROETHANE	12/21/98	0.004		3.65	3.65	
SW00396	1,1-DICHLOROETHANE	2/9/99	0.003		3.65	3.65	
SW00396	1,1-DICHLOROETHANE	3/29/99	0.0034		3.65	3.65	
SW00396	1,1-DICHLOROETHANE	4/12/99	0.004		3.65	3.65	
SW00396	1,1-DICHLOROETHANE	11/1/99	0.004		3.65	3.65	
SW097	1,1-DICHLOROETHANE	4/6/89	0.012		3.65	3.65	
SW097	1,1-DICHLOROETHANE	5/19/89	0.008		3.65	3.65	
SW097	1,1-DICHLOROETHANE	6/20/89	0.005		3.65	3.65	
SW097	1,1-DICHLOROETHANE	7/7/89	0.004	J	3.65	3.65	
SW097	1,1-DICHLOROETHANE	8/2/89	0.005		3.65	3.65	
SW097	1,1-DICHLOROETHANE	10/9/89	0.005		3.65	3.65	
SW097	1,1-DICHLOROETHANE	11/7/89	0.008		3.65	3.65	
SW097	1,1-DICHLOROETHANE	2/13/90	0.002	J	3.65	3.65	
SW097	1,1-DICHLOROETHANE	3/23/90	0.007		3.65	3.65	
SW097	1,1-DICHLOROETHANE	5/3/90	0.006		3.65	3.65	
SW097	1,1-DICHLOROETHANE	6/5/90	0.008		3.65	3.65	
SW097	1,1-DICHLOROETHANE	8/2/90	0.006		3.65	3.65	
SW097	1,1-DICHLOROETHANE	9/6/90	0.007		3.65	3.65	
SW097	1,1-DICHLOROETHANE	10/4/90	0.009		3.65	3.65	
SW097	1,1-DICHLOROETHANE	11/13/90	0.007		3.65	3.65	
SW097	1,1-DICHLOROETHANE	4/3/91	0.006		3.65	3.65	
SW097	1,1-DICHLOROETHANE	5/2/91	0.007		3.65	3.65	
SW097	1,1-DICHLOROETHANE	6/19/91	0.007		3.65	3.65	
SW097	1,1-DICHLOROETHANE	7/29/91	0.01		3.65	3.65	
SW097	1,1-DICHLOROETHANE	8/28/91	0.01		3.65	3.65	
SW097	1,1-DICHLOROETHANE	9/25/91	0.008		3.65	3.65	
SW097	1,1-DICHLOROETHANE	10/9/91	0.008		3.65	3.65	
SW097	1,1-DICHLOROETHANE	12/17/92	0.006		3.65	3.65	
SW097	1,1-DICHLOROETHANE	1/25/93	0.007		3.65	3.65	
SW097	1,1-DICHLOROETHANE	2/26/93	0.008		3.65	3.65	
SW097	1,1-DICHLOROETHANE	3/24/93	0.008		3.65	3.65	
SW10795	1,1-DICHLOROETHANE	7/3/95	0.004	J	3.65	3.65	
SW00196	1,1-DICHLOROETHENE	1/20/97	0.0017		3.65	0.007	
SW00196	1,2,4-TRICHLOROBENZENE	10/8/97	0.00067	J	0.365	0.05	

Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW00196	1,2,4-TRICHLOROBENZENE	11/1/99	0.0003	JB	0.365	0.05	
SW00196	1,2,4-TRICHLOROBENZENE	6/19/00	0.0002		0.365	0.05	
SW00196	1,2,4-TRICHLOROBENZENE	12/4/00	0.0002	J	0.365	0.05	
SW00196	1,2,4-TRICHLOROBENZENE	3/19/01	0.0002	JB	0.365	0.05	
SW00196	1,2,4-TRICHLOROBENZENE	6/12/01	0.0002	BJ	0.365	0.05	
SW00396	1,2,4-TRICHLOROBENZENE	4/12/99	0.0002	J	0.365	0.05	
SW00396	1,2,4-TRICHLOROBENZENE	11/1/99	0.0003	JB	0.365	0.05	
SW00196	1,2-DICHLOROBENZENE	10/8/97	0.00027	J	3.29	0.62	
SW00196	1,2-DICHLOROBENZENE	11/1/99	0.0007	J	3.29	0.62	
SW00196	1,2-DICHLOROBENZENE	6/19/00	0.0004	J	3.29	0.62	
SW00196	1,2-DICHLOROBENZENE	7/11/00	0.0004	J	3.29	0.62	
SW00196	1,2-DICHLOROBENZENE	12/4/00	0.0004	J	3.29	0.62	
SW00196	1,2-DICHLOROBENZENE	3/19/01	0.0003	J	3.29	0.62	
SW00196	1,2-DICHLOROBENZENE	6/12/01	0.0004	J	3.29	0.62	
SW00196	1,2-DICHLOROBENZENE	9/24/01	0.00035	J	3.29	0.62	
SW00396	1,2-DICHLOROBENZENE	10/8/97	0.00044	J	3.29	0.62	
SW00396	1,2-DICHLOROBENZENE	10/15/97	0.00048	J	3.29	0.62	
SW00396	1,2-DICHLOROBENZENE	12/8/97	0.00047	J	3.29	0.62	
SW00396	1,2-DICHLOROBENZENE	1/15/98	0.00054	J	3.29	0.62	
SW00396	1,2-DICHLOROBENZENE	4/12/99	0.0007	J	3.29	0.62	
SW00396	1,2-DICHLOROBENZENE	11/1/99	0.0009	J	3.29	0.62	
SW097	1,2-DICHLOROETHENE	11/7/89	0.004	J	0.329	0.07	
SW097	1,2-DICHLOROETHENE	1/12/90	0.007		0.329	0.07	
SW097	1,2-DICHLOROETHENE	2/13/90	0.002	J	0.329	0.07	
SW097	1,2-DICHLOROETHENE	3/23/90	0.014		0.329	0.07	
SW097	1,2-DICHLOROETHENE	7/6/90	0.004	J	0.329	0.07	
SW097	1,2-DICHLOROETHENE	9/6/90	0.003	J	0.329	0.07	
SW097	1,2-DICHLOROETHENE	10/4/90	0.005		0.329	0.07	
SW097	1,2-DICHLOROETHENE	11/13/90	0.005		0.329	0.07	
SW097	1,2-DICHLOROETHENE	5/2/91	0.005		0.329	0.07	
SW097	1,2-DICHLOROETHENE	7/29/91	0.004	J	0.329	0.07	
SW097	1,2-DICHLOROETHENE	8/28/91	0.004	J	0.329	0.07	
SW00396	1,2-DICHLOROPROPANE	4/12/99	0.0001	J	0.00125	0.001	PQL
SW00396	1,2-DICHLOROPROPANE	11/1/99	0.0002	J	0.00125	0.001	PQL
SW00196	1,3-DICHLOROBENZENE	11/1/99	0.0006	J	0.0329	0.4	
SW00196	1,3-DICHLOROBENZENE	6/19/00	0.0002	J	0.0329	0.4	
SW00196	1,3-DICHLOROBENZENE	7/11/00	0.0001	J	0.0329	0.4	
SW00196	1,3-DICHLOROBENZENE	12/4/00	0.0002	J	0.0329	0.4	
SW00196	1,3-DICHLOROBENZENE	3/19/01	0.0001	J	0.0329	0.4	
SW00196	1,3-DICHLOROBENZENE	6/12/01	0.0001	J	0.0329	0.4	
SW00396	1,3-DICHLOROBENZENE	4/12/99	0.0005	J	0.0329	0.4	
SW00396	1,3-DICHLOROBENZENE	11/1/99	0.0006	J	0.0329	0.4	
SW00196	1,4-DICHLOROBENZENE	11/1/99	0.0002	J	0.00355	0.075	
SW00196	1,4-DICHLOROBENZENE	6/19/00	0.0005	J	0.00355	0.075	
SW00196	1,4-DICHLOROBENZENE	7/11/00	0.0004	J	0.00355	0.075	
SW00196	1,4-DICHLOROBENZENE	12/4/00	0.0005	J	0.00355	0.075	
SW00196	1,4-DICHLOROBENZENE	3/19/01	0.0004	J	0.00355	0.075	
SW00196	1,4-DICHLOROBENZENE	6/12/01	0.0004	J	0.00355	0.075	
SW00196	1,4-DICHLOROBENZENE	9/24/01	0.0005	J	0.00355	0.075	
SW00296	1,4-DICHLOROBENZENE	12/8/97	0.0006	J	0.00355	0.075	
SW00396	1,4-DICHLOROBENZENE	10/8/97	0.00056	J	0.00355	0.075	
SW00396	1,4-DICHLOROBENZENE	10/15/97	0.00061	J	0.00355	0.075	
SW00396	1,4-DICHLOROBENZENE	12/8/97	0.00055	J	0.00355	0.075	
SW00396	1,4-DICHLOROBENZENE	1/15/98	0.00066	J	0.00355	0.075	
SW00396	1,4-DICHLOROBENZENE	12/21/98	0.0006	J	0.00355	0.075	
SW00396	1,4-DICHLOROBENZENE	3/29/99	0.00057	J	0.00355	0.075	
SW00396	1,4-DICHLOROBENZENE	4/12/99	0.0002	J	0.00355	0.075	
SW00396	1,4-DICHLOROBENZENE	11/1/99	0.0003	J	0.00355	0.075	
SW00196	2,4-DIMETHYLPHENOL	11/17/98	0.001	J	0.73	0.14	
SW097	2,4-DIMETHYLPHENOL	10/9/89	0.002	J	0.73	0.14	
SW097	2,4-DIMETHYLPHENOL	10/4/90	0.002	J	0.73	0.14	
SW097	2,4-DIMETHYLPHENOL	10/9/91	0.003	J	0.73	0.14	
SW097	2,4-DIMETHYLPHENOL	12/17/92	0.002	J	0.73	0.14	
SW00196	2-BUTANONE	5/29/96	0.004	J	21.9	21.9	
SW00196	2-BUTANONE	12/21/98	0.017		21.9	21.9	
SW00196	2-BUTANONE	6/12/01	0.002	J	21.9	21.9	
SW00296	2-BUTANONE	10/30/96	0.0037		21.9	21.9	
SW097	2-BUTANONE	6/20/89	0.013		21.9	21.9	
SW097	2-BUTANONE	8/2/89	0.009	J	21.9	21.9	
SW097	2-BUTANONE	1/12/90	0.076		21.9	21.9	
SW097	2-BUTANONE	2/13/90	0.023		21.9	21.9	
SW097	2-BUTANONE	5/3/90	0.04		21.9	21.9	
SW097	2-BUTANONE	8/2/90	0.011		21.9	21.9	

Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW097	2-BUTANONE	5/2/91	0.006	J	21.9	21.9	
SW00196	2-METHYLNAPHTHALENE	5/29/96	0.002	J	0.73	NS	
SW00196	2-METHYLNAPHTHALENE	11/17/98	0.003	J	0.73	NS	
SW00196	2-METHYLNAPHTHALENE	12/21/98	0.006	J	0.73	NS	
SW00196	2-METHYLNAPHTHALENE	1/18/99	0.001	J	0.73	NS	
SW00196	2-METHYLNAPHTHALENE	3/29/99	0.0031	J	0.73	NS	
SW00296	2-METHYLNAPHTHALENE	12/8/97	0.0027	J	0.73	NS	
SW00396	2-METHYLNAPHTHALENE	10/8/97	0.0031	J	0.73	NS	
SW00396	2-METHYLNAPHTHALENE	10/15/97	0.0058	J	0.73	NS	
SW00396	2-METHYLNAPHTHALENE	11/10/97	0.0022	J	0.73	NS	
SW00396	2-METHYLNAPHTHALENE	12/8/97	0.0027	J	0.73	NS	
SW00396	2-METHYLNAPHTHALENE	1/15/98	0.0064	J	0.73	NS	
SW00396	2-METHYLNAPHTHALENE	11/17/98	0.003	J	0.73	NS	
SW00396	2-METHYLNAPHTHALENE	12/21/98	0.008	J	0.73	NS	
SW00396	2-METHYLNAPHTHALENE	1/18/99	0.002	J	0.73	NS	
SW00396	2-METHYLNAPHTHALENE	2/9/99	0.001	J	0.73	NS	
SW00396	2-METHYLNAPHTHALENE	3/29/99	0.0032	J	0.73	NS	
SW00396	2-METHYLNAPHTHALENE	4/12/99	0.002	J	0.73	NS	
SW097	2-METHYLNAPHTHALENE	4/6/89	0.013		0.73	NS	
SW097	2-METHYLNAPHTHALENE	5/19/89	0.015		0.73	NS	
SW097	2-METHYLNAPHTHALENE	10/9/89	0.009	J	0.73	NS	
SW097	2-METHYLNAPHTHALENE	10/4/90	0.029		0.73	NS	
SW097	2-METHYLNAPHTHALENE	4/3/91	0.015		0.73	NS	
SW097	2-METHYLNAPHTHALENE	10/9/91	0.023		0.73	NS	
SW097	2-METHYLNAPHTHALENE	12/17/92	0.015		0.73	NS	
SW097	2-METHYLNAPHTHALENE	1/25/93	0.012		0.73	NS	
SW097	2-METHYLNAPHTHALENE	2/26/93	0.015		0.73	NS	
SW097	2-METHYLNAPHTHALENE	3/24/93	0.019		0.73	NS	
SW097	4-METHYL-2-PENTANONE	4/6/89	0.002	J	2.92	2.92	
SW097	4-METHYL-2-PENTANONE	5/19/89	0.002	J	2.92	2.92	
SW097	4-METHYL-2-PENTANONE	6/20/89	0.015		2.92	2.92	
SW097	4-METHYL-2-PENTANONE	7/7/89	0.009	J	2.92	2.92	
SW097	4-METHYL-2-PENTANONE	8/2/89	0.012		2.92	2.92	
SW097	4-METHYL-2-PENTANONE	1/12/90	0.022		2.92	2.92	
SW097	4-METHYL-2-PENTANONE	3/23/90	0.087	J	2.92	2.92	
SW097	4-METHYL-2-PENTANONE	5/3/90	0.019	B	2.92	2.92	
SW097	4-METHYL-2-PENTANONE	6/5/90	0.012	B	2.92	2.92	
SW097	4-METHYL-2-PENTANONE	7/6/90	0.011	B	2.92	2.92	
SW00196	4-METHYLPHENOL	8/21/00	0.001	J	0.183	NS	
SW097	4-METHYLPHENOL	5/19/89	0.004	J	0.183	NS	
SW097	4-METHYLPHENOL	10/9/89	0.029		0.183	NS	
SW097	4-METHYLPHENOL	10/4/90	0.024		0.183	NS	
SW097	4-METHYLPHENOL	4/3/91	0.004	J	0.183	NS	
SW097	4-METHYLPHENOL	12/17/92	0.003	J	0.183	NS	
SW097	4-METHYLPHENOL	1/25/93	0.002	J	0.183	NS	
SW00196	ACENAPHTHENE	11/17/98	0.003	J	2.19	0.42	
SW00196	ACENAPHTHENE	12/21/98	0.003	J	2.19	0.42	
SW00196	ACENAPHTHENE	1/18/99	0.002	J	2.19	0.42	
SW00196	ACENAPHTHENE	2/9/99	0.003	J	2.19	0.42	
SW00196	ACENAPHTHENE	3/29/99	0.0021	J	2.19	0.42	
SW00196	ACENAPHTHENE	11/1/99	0.003	J	2.19	0.42	
SW00196	ACENAPHTHENE	7/24/00	0.002	J	2.19	0.42	
SW00196	ACENAPHTHENE	8/21/00	0.001	J	2.19	0.42	
SW00296	ACENAPHTHENE	12/8/97	0.0041	J	2.19	0.42	
SW00396	ACENAPHTHENE	8/13/97	0.0011	J	2.19	0.42	
SW00396	ACENAPHTHENE	10/8/97	0.0021	J	2.19	0.42	
SW00396	ACENAPHTHENE	11/10/97	0.002	J	2.19	0.42	
SW00396	ACENAPHTHENE	12/8/97	0.004	J	2.19	0.42	
SW00396	ACENAPHTHENE	1/15/98	0.0049	J	2.19	0.42	
SW00396	ACENAPHTHENE	11/17/98	0.003	J	2.19	0.42	
SW00396	ACENAPHTHENE	12/21/98	0.004	J	2.19	0.42	
SW00396	ACENAPHTHENE	1/18/99	0.003	J	2.19	0.42	
SW00396	ACENAPHTHENE	2/9/99	0.003	J	2.19	0.42	
SW00396	ACENAPHTHENE	3/29/99	0.0022	J	2.19	0.42	
SW00396	ACENAPHTHENE	4/12/99	0.003	J	2.19	0.42	
SW00396	ACENAPHTHENE	11/1/99	0.003	J	2.19	0.42	
SW097	ACENAPHTHENE	4/6/89	0.002	J	2.19	0.42	
SW097	ACENAPHTHENE	5/19/89	0.002	J	2.19	0.42	
SW097	ACENAPHTHENE	10/9/89	0.001	J	2.19	0.42	
SW097	ACENAPHTHENE	10/4/90	0.003	J	2.19	0.42	
SW097	ACENAPHTHENE	4/3/91	0.002	J	2.19	0.42	
SW097	ACENAPHTHENE	10/9/91	0.003	J	2.19	0.42	
SW097	ACENAPHTHENE	12/17/92	0.003	J	2.19	0.42	

Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW097	ACENAPHTHENE	1/25/93	0.003	J	2.19	0.42	
SW097	ACENAPHTHENE	2/26/93	0.003	J	2.19	0.42	
SW097	ACENAPHTHENE	3/24/93	0.004	J	2.19	0.42	
SW00196	ACETONE	5/29/96	0.022	B	3.65	3.65	
SW00196	ACETONE	1/20/97	0.00067	J	3.65	3.65	
SW00196	ACETONE	10/15/97	0.0058	JB	3.65	3.65	
SW00196	ACETONE	12/21/98	0.024		3.65	3.65	
SW00196	ACETONE	11/1/99	0.003	JB	3.65	3.65	
SW00196	ACETONE	6/19/00	0.006		3.65	3.65	
SW00196	ACETONE	12/4/00	0.003	J	3.65	3.65	
SW00196	ACETONE	3/19/01	0.008		3.65	3.65	
SW00196	ACETONE	6/12/01	0.008	BJ	3.65	3.65	
SW00196	ACETONE	9/24/01	0.0053	J	3.65	3.65	
SW00196	ACETONE	12/3/01	0.0072	J	3.65	3.65	
SW00296	ACETONE	10/30/96	0.0052		3.65	3.65	
SW00296	ACETONE	1/20/97	0.0018	J	3.65	3.65	
SW00296	ACETONE	10/15/97	0.0062	J	3.65	3.65	
SW00396	ACETONE	10/8/97	0.0071	J	3.65	3.65	
SW00396	ACETONE	10/15/97	0.0085	J	3.65	3.65	
SW00396	ACETONE	4/12/99	0.002	JB	3.65	3.65	
SW00396	ACETONE	11/1/99	0.002	JB	3.65	3.65	
SW097	ACETONE	4/6/89	0.011	B	3.65	3.65	
SW097	ACETONE	6/20/89	0.037		3.65	3.65	
SW097	ACETONE	7/7/89	0.026		3.65	3.65	
SW097	ACETONE	1/12/90	0.083	J	3.65	3.65	
SW097	ACETONE	2/13/90	0.12	B	3.65	3.65	
SW097	ACETONE	3/23/90	0.22		3.65	3.65	
SW097	ACETONE	5/3/90	0.06	B	3.65	3.65	
SW097	ACETONE	6/5/90	0.019	B	3.65	3.65	
SW097	ACETONE	8/2/90	0.026		3.65	3.65	
SW097	ACETONE	9/6/90	0.012	B	3.65	3.65	
SW097	ACETONE	5/2/91	0.013		3.65	3.65	
SW097	ACETONE	6/19/91	0.024		3.65	3.65	
SW097	ACETONE	10/9/91	0.043	B	3.65	3.65	
SW097	ACETONE	12/17/92	0.025		3.65	3.65	
SW00196	ANTHRACENE	11/1/99	0.0006	J	11	2.1	
SW00396	ANTHRACENE	4/12/99	0.0006	J	11	2.1	
SW00396	ANTHRACENE	11/1/99	0.0006	J	11	2.1	
SW00196	BENZENE	5/29/96	0.0003	J	0.00294	0.0012	
SW00196	BENZENE	6/16/97	0.00033	J	0.00294	0.0012	
SW00196	BENZENE	12/21/98	0.0008	J	0.00294	0.0012	
SW00196	BENZENE	1/18/99	0.001		0.00294	0.0012	
SW00196	BENZENE	2/9/99	0.001		0.00294	0.0012	
SW00196	BENZENE	3/29/99	0.0011		0.00294	0.0012	
SW00196	BENZENE	11/1/99	**0.002**		0.00294	**0.0012**	
SW00196	BENZENE	7/11/00	0.001		0.00294	0.0012	
SW00196	BENZENE	12/4/00	**0.002**		0.00294	**0.0012**	
SW00196	BENZENE	3/19/01	0.001		0.00294	0.0012	
SW00196	BENZENE	6/12/01	**0.002**		0.00294	**0.0012**	
SW00196	BENZENE	9/24/01	**0.0014**		0.00294	**0.0012**	
SW00196	BENZENE	12/3/01	0.00031	J	0.00294	0.0012	
SW00296	BENZENE	11/20/96	0.00076	J	0.00294	0.0012	
SW00296	BENZENE	1/20/97	0.00024	J	0.00294	0.0012	
SW00296	BENZENE	10/8/97	0.00059	J	0.00294	0.0012	
SW00296	BENZENE	12/8/97	**0.0019**		0.00294	**0.0012**	
SW00296	BENZENE	1/15/98	0.0011		0.00294	0.0012	
SW00396	BENZENE	8/13/97	0.0012		0.00294	0.0012	
SW00396	BENZENE	9/8/97	0.0011		0.00294	0.0012	
SW00396	BENZENE	10/8/97	**0.0015**		0.00294	**0.0012**	
SW00396	BENZENE	11/10/97	**0.0018**		0.00294	**0.0012**	
SW00396	BENZENE	12/8/97	**0.0017**		0.00294	**0.0012**	
SW00396	BENZENE	1/15/98	**0.0021**		0.00294	**0.0012**	
SW00396	BENZENE	12/21/98	**0.002**		0.00294	**0.0012**	
SW00396	BENZENE	1/18/99	**0.002**		0.00294	**0.0012**	
SW00396	BENZENE	2/9/99	**0.002**		0.00294	**0.0012**	
SW00396	BENZENE	3/29/99	**0.0018**		0.00294	**0.0012**	
SW00396	BENZENE	4/12/99	**0.002**		0.00294	**0.0012**	
SW00396	BENZENE	11/1/99	**0.002**		0.00294	**0.0012**	
SW097	BENZENE	4/6/89	**0.002**	J	0.00294	**0.0012**	
SW097	BENZENE	5/19/89	0.001	J	0.00294	0.0012	
SW097	BENZENE	3/23/90	0.001	J	0.00294	0.0012	
SW097	BENZENE	5/3/90	0.001	J	0.00294	0.0012	
SW097	BENZENE	6/5/90	**0.002**	J	0.00294	**0.0012**	

Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW097	BENZENE	7/6/90	0.001	J	0.00294	0.0012	
SW097	BENZENE	8/2/90	0.001	J	0.00294	0.0012	
SW097	BENZENE	9/6/90	0.001	J	0.00294	0.0012	
SW097	BENZENE	10/4/90	**0.002**	J	0.00294	**0.0012**	
SW097	BENZENE	11/13/90	0.001	J	0.00294	0.0012	
SW097	BENZENE	4/3/91	**0.002**	J	0.00294	**0.0012**	
SW097	BENZENE	7/29/91	**0.002**	J	0.00294	**0.0012**	
SW097	BENZENE	8/28/91	**0.002**	J	0.00294	**0.0012**	
SW097	BENZENE	12/17/92	0.001	J	0.00294	0.0012	
SW00196	BENZOIC ACID	11/17/98	0.005	J	146	NS	
SW00196	BENZOIC ACID	12/21/98	0.006	BJ	146	NS	
SW00196	BENZOIC ACID	1/18/99	0.008	J	146	NS	
SW00196	BENZOIC ACID	2/9/99	0.015	DJ	146	NS	
SW00196	BENZOIC ACID	11/1/99	0.006	J	146	NS	
SW00196	BENZOIC ACID	7/24/00	0.008	J	146	NS	
SW00196	BENZOIC ACID	8/21/00	0.0006	J	146	NS	
SW00396	BENZOIC ACID	11/17/98	0.005	J	146	NS	
SW00396	BENZOIC ACID	12/21/98	0.005	J	146	NS	
SW00396	BENZOIC ACID	1/18/99	0.008	J	146	NS	
SW00396	BENZOIC ACID	2/9/99	0.01	J	146	NS	
SW00396	BENZOIC ACID	11/1/99	0.007	J	146	NS	
SW097	BENZOIC ACID	10/9/89	0.006	J	146	NS	
SW097	BENZYL ALCOHOL	10/9/89	0.002	J	11	NS	
SW00196	BIS(2-ETHYLHEXYL)PHTHALATE	5/29/96	0.005	J	0.01	0.01	PQL
SW00196	BIS(2-ETHYLHEXYL)PHTHALATE	1/20/97	0.0049	JB	0.01	0.01	PQL
SW00196	BIS(2-ETHYLHEXYL)PHTHALATE	9/8/97	0.0011	J	0.01	0.01	PQL
SW00196	BIS(2-ETHYLHEXYL)PHTHALATE	12/8/97	0.0037	J,B	0.01	0.01	PQL
SW00196	BIS(2-ETHYLHEXYL)PHTHALATE	11/17/98	0.002	BJ	0.01	0.01	PQL
SW00196	BIS(2-ETHYLHEXYL)PHTHALATE	12/21/98	**0.065**		**0.01**	**0.01**	PQL
SW00196	BIS(2-ETHYLHEXYL)PHTHALATE	2/9/99	**0.14**	BD	**0.01**	**0.01**	PQL
SW00196	BIS(2-ETHYLHEXYL)PHTHALATE	11/1/99	0.002	JB	0.01	0.01	PQL
SW00196	BIS(2-ETHYLHEXYL)PHTHALATE	7/24/00	0.002	JB	0.01	0.01	PQL
SW00196	BIS(2-ETHYLHEXYL)PHTHALATE	8/21/00	0.002	JB	0.01	0.01	PQL
SW00296	BIS(2-ETHYLHEXYL)PHTHALATE	12/8/97	0.0037	J,B	0.01	0.01	PQL
SW00396	BIS(2-ETHYLHEXYL)PHTHALATE	9/8/97	0.0016	J	0.01	0.01	PQL
SW00396	BIS(2-ETHYLHEXYL)PHTHALATE	12/8/97	0.003	J,B	0.01	0.01	PQL
SW00396	BIS(2-ETHYLHEXYL)PHTHALATE	1/15/98	0.0013	J,B	0.01	0.01	PQL
SW00396	BIS(2-ETHYLHEXYL)PHTHALATE	11/17/98	**0.013**	B	**0.01**	**0.01**	PQL
SW00396	BIS(2-ETHYLHEXYL)PHTHALATE	12/21/98	0.01		0.01	0.01	PQL
SW00396	BIS(2-ETHYLHEXYL)PHTHALATE	2/9/99	**0.023**	B	**0.01**	**0.01**	PQL
SW00396	BIS(2-ETHYLHEXYL)PHTHALATE	4/12/99	0.001	J	0.01	0.01	PQL
SW00396	BIS(2-ETHYLHEXYL)PHTHALATE	11/1/99	0.003	JB	0.01	0.01	PQL
SW097	BIS(2-ETHYLHEXYL)PHTHALATE	5/19/89	0.005	J	0.01	0.01	PQL
SW097	BIS(2-ETHYLHEXYL)PHTHALATE	10/9/89	0.001	J	0.01	0.01	PQL
SW097	BIS(2-ETHYLHEXYL)PHTHALATE	1/25/93	0.002	J	0.01	0.01	PQL
SW00196	BROMOFORM	12/4/00	0.0007	J	0.0108	0.0043	
SW00196	BUTYL BENZYL PHTHALATE	5/29/96	0.004	J	7.3	1.4	
SW00196	BUTYL BENZYL PHTHALATE	12/21/98	0.002	J	7.3	1.4	
SW00196	BUTYL BENZYL PHTHALATE	7/24/00	0.0007	J	7.3	1.4	
SW00196	BUTYL BENZYL PHTHALATE	8/21/00	0.002	J	7.3	1.4	
SW00396	BUTYL BENZYL PHTHALATE	12/21/98	0.002	J	7.3	1.4	
SW097	CARBON DISULFIDE	2/13/90	0.006		3.65	3.65	
SW00196	CHLOROBENZENE	11/1/99	0.0006	J	0.73	0.1	
SW00196	CHLOROBENZENE	6/19/00	0.0005	J	0.73	0.1	
SW00196	CHLOROBENZENE	7/11/00	0.0004	J	0.73	0.1	
SW00196	CHLOROBENZENE	6/12/01	0.0004	J	0.73	0.1	
SW00196	CHLOROBENZENE	9/24/01	0.00038	J	0.73	0.1	
SW00396	CHLOROBENZENE	10/8/97	0.00029	J	0.73	0.1	
SW00396	CHLOROBENZENE	10/15/97	0.00037	J	0.73	0.1	
SW00396	CHLOROBENZENE	1/15/98	0.00054	J	0.73	0.1	
SW00396	CHLOROBENZENE	3/29/99	0.0005	J	0.73	0.1	
SW00396	CHLOROBENZENE	4/12/99	0.0006	J	0.73	0.1	
SW00396	CHLOROBENZENE	11/1/99	0.0007	J	0.73	0.1	
SW00196	CHLOROETHANE	9/13/96	0.023		0.0294	0.0294	
SW00196	CHLOROETHANE	11/20/96	0.021		0.0294	0.0294	
SW00196	CHLOROETHANE	1/20/97	0.0047		0.0294	0.0294	
SW00196	CHLOROETHANE	6/16/97	0.019		0.0294	0.0294	
SW00196	CHLOROETHANE	9/8/97	0.011		0.0294	0.0294	
SW00196	CHLOROETHANE	10/8/97	0.016		0.0294	0.0294	
SW00196	CHLOROETHANE	11/10/97	0.015		0.0294	0.0294	
SW00196	CHLOROETHANE	12/8/97	0.018		0.0294	0.0294	
SW00196	CHLOROETHANE	1/15/98	0.017		0.0294	0.0294	
SW00196	CHLOROETHANE	12/21/98	0.012		0.0294	0.0294	

Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW00196	CHLOROETHANE	2/9/99	0.012		0.0294	0.0294	
SW00196	CHLOROETHANE	3/29/99	0.0102		0.0294	0.0294	
SW00196	CHLOROETHANE	11/1/99	0.012		0.0294	0.0294	
SW00196	CHLOROETHANE	6/19/00	0.01		0.0294	0.0294	
SW00196	CHLOROETHANE	7/11/00	0.011		0.0294	0.0294	
SW00196	CHLOROETHANE	12/4/00	0.014		0.0294	0.0294	
SW00196	CHLOROETHANE	3/19/01	0.012		0.0294	0.0294	
SW00196	CHLOROETHANE	6/12/01	0.016		0.0294	0.0294	
SW00196	CHLOROETHANE	9/24/01	0.012		0.0294	0.0294	
SW00196	CHLOROETHANE	12/3/01	0.0026		0.0294	0.0294	
SW00296	CHLOROETHANE	9/13/96	0.022		0.0294	0.0294	
SW00296	CHLOROETHANE	10/30/96	0.025		0.0294	0.0294	
SW00296	CHLOROETHANE	11/20/96	0.021		0.0294	0.0294	
SW00296	CHLOROETHANE	1/20/97	**0.035**		**0.0294**	**0.0294**	
SW00296	CHLOROETHANE	2/19/97	**0.03**		**0.0294**	**0.0294**	
SW00296	CHLOROETHANE	4/23/97	**0.036**		**0.0294**	**0.0294**	
SW00296	CHLOROETHANE	8/13/97	0.0044		0.0294	0.0294	
SW00296	CHLOROETHANE	9/8/97	0.0096		0.0294	0.0294	
SW00296	CHLOROETHANE	10/8/97	0.016		0.0294	0.0294	
SW00296	CHLOROETHANE	11/10/97	0.017		0.0294	0.0294	
SW00296	CHLOROETHANE	12/8/97	0.018		0.0294	0.0294	
SW00296	CHLOROETHANE	1/15/98	0.019		0.0294	0.0294	
SW00396	CHLOROETHANE	8/13/97	0.013		0.0294	0.0294	
SW00396	CHLOROETHANE	9/8/97	0.012		0.0294	0.0294	
SW00396	CHLOROETHANE	10/8/97	0.015		0.0294	0.0294	
SW00396	CHLOROETHANE	11/10/97	0.015		0.0294	0.0294	
SW00396	CHLOROETHANE	12/8/97	0.015		0.0294	0.0294	
SW00396	CHLOROETHANE	1/15/98	0.016		0.0294	0.0294	
SW00396	CHLOROETHANE	12/21/98	0.019		0.0294	0.0294	
SW00396	CHLOROETHANE	2/9/99	0.015		0.0294	0.0294	
SW00396	CHLOROETHANE	3/29/99	0.0194		0.0294	0.0294	
SW00396	CHLOROETHANE	4/12/99	0.024		0.0294	0.0294	
SW00396	CHLOROETHANE	11/1/99	0.015		0.0294	0.0294	
SW097	CHLOROETHANE	6/16/88	0.007	J	0.0294	0.0294	
SW097	CHLOROETHANE	6/20/89	0.009	J	0.0294	0.0294	
SW097	CHLOROETHANE	8/2/89	0.015		0.0294	0.0294	
SW097	CHLOROETHANE	11/7/89	0.02		0.0294	0.0294	
SW097	CHLOROETHANE	5/3/90	0.017		0.0294	0.0294	
SW097	CHLOROETHANE	6/5/90	0.024		0.0294	0.0294	
SW097	CHLOROETHANE	7/6/90	0.015		0.0294	0.0294	
SW097	CHLOROETHANE	8/2/90	0.014		0.0294	0.0294	
SW097	CHLOROETHANE	9/6/90	0.011		0.0294	0.0294	
SW097	CHLOROETHANE	4/3/91	0.024		0.0294	0.0294	
SW097	CHLOROETHANE	5/2/91	**0.034**		**0.0294**	**0.0294**	
SW097	CHLOROETHANE	6/19/91	0.022		0.0294	0.0294	
SW097	CHLOROETHANE	7/29/91	0.029		0.0294	0.0294	
SW097	CHLOROETHANE	8/28/91	0.026		0.0294	0.0294	
SW097	CHLOROETHANE	9/25/91	0.021		0.0294	0.0294	
SW097	CHLOROETHANE	10/9/91	0.021		0.0294	0.0294	
SW097	CHLOROETHANE	12/17/92	**0.057**		**0.0294**	**0.0294**	
SW097	CHLOROETHANE	1/25/93	**0.04**		**0.0294**	**0.0294**	
SW097	CHLOROETHANE	2/26/93	**0.039**		**0.0294**	**0.0294**	
SW097	CHLOROETHANE	3/24/93	**0.062**		**0.0294**	**0.0294**	
SW10795	CHLOROETHANE	7/3/95	**0.03**		**0.0294**	**0.0294**	
SW00396	CHLOROFORM	10/8/97	0.00059	J	0.014	0.0057	
SW097	CHLOROFORM	5/3/90	0.002	J	0.014	0.0057	
SW00196	cis-1,2-DICHLOROETHENE	11/1/99	0.0005	J	0.329	0.07	
SW00196	cis-1,2-DICHLOROETHENE	6/19/00	0.0002	J	0.329	0.07	
SW00196	cis-1,2-DICHLOROETHENE	7/11/00	0.0002	J	0.329	0.07	
SW00196	cis-1,2-DICHLOROETHENE	12/4/00	0.0001	J	0.329	0.07	
SW00196	cis-1,2-DICHLOROETHENE	6/12/01	0.0002	J	0.329	0.07	
SW00296	cis-1,2-DICHLOROETHENE	12/8/97	0.0005	J	0.329	0.07	
SW00296	cis-1,2-DICHLOROETHENE	1/15/98	0.00038	J	0.329	0.07	
SW00396	cis-1,2-DICHLOROETHENE	10/15/97	0.00044	J	0.329	0.07	
SW00396	cis-1,2-DICHLOROETHENE	12/8/97	0.00042	J	0.329	0.07	
SW00396	cis-1,2-DICHLOROETHENE	1/15/98	0.00052	J	0.329	0.07	
SW00396	cis-1,2-DICHLOROETHENE	4/12/99	0.0004	J	0.329	0.07	
SW00396	cis-1,2-DICHLOROETHENE	11/1/99	0.0006	J	0.329	0.07	
SW00196	DIBENZOFURAN	11/17/98	0.002	J	0.146	NS	
SW00196	DIBENZOFURAN	12/21/98	0.002	J	0.146	NS	
SW00196	DIBENZOFURAN	1/18/99	0.001	J	0.146	NS	
SW00196	DIBENZOFURAN	2/9/99	0.001	J	0.146	NS	
SW00196	DIBENZOFURAN	11/1/99	0.002	J	0.146	NS	

Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW00196	DIBENZOFURAN	7/24/00	0.001	J	0.146	NS	
SW00196	DIBENZOFURAN	8/21/00	0.0006	J	0.146	NS	
SW00396	DIBENZOFURAN	10/8/97	0.0012	J	0.146	NS	
SW00396	DIBENZOFURAN	11/17/98	0.002	J	0.146	NS	
SW00396	DIBENZOFURAN	12/21/98	0.002	J	0.146	NS	
SW00396	DIBENZOFURAN	1/18/99	0.001	J	0.146	NS	
SW00396	DIBENZOFURAN	2/9/99	0.002	J	0.146	NS	
SW00396	DIBENZOFURAN	4/12/99	0.002	J	0.146	NS	
SW00396	DIBENZOFURAN	11/1/99	0.002	J	0.146	NS	
SW097	DIBENZOFURAN	4/3/91	0.001	J	0.146	NS	
SW097	DIBENZOFURAN	10/9/91	0.002	J	0.146	NS	
SW097	DIBENZOFURAN	12/17/92	0.001	J	0.146	NS	
SW097	DIBENZOFURAN	1/25/93	0.001	J	0.146	NS	
SW097	DIBENZOFURAN	2/26/93	0.002	J	0.146	NS	
SW097	DIBENZOFURAN	3/24/93	0.002	J	0.146	NS	
SW00196	DIETHYL PHTHALATE	5/29/96	0.003	BJ	29.2	5.6	
SW00196	DIETHYL PHTHALATE	12/21/98	0.001	J	29.2	5.6	
SW00196	DIETHYL PHTHALATE	11/1/99	0.0009	J	29.2	5.6	
SW00196	DIETHYL PHTHALATE	7/24/00	0.0008	JB	29.2	5.6	
SW00196	DIETHYL PHTHALATE	8/21/00	0.0007	JB	29.2	5.6	
SW00396	DIETHYL PHTHALATE	11/17/98	0.001	J	29.2	5.6	
SW00396	DIETHYL PHTHALATE	12/21/98	0.002	J	29.2	5.6	
SW00396	DIETHYL PHTHALATE	11/1/99	0.0009	J	29.2	5.6	
SW097	DIETHYL PHTHALATE	10/9/89	0.004	J	29.2	5.6	
SW097	DIETHYL PHTHALATE	4/3/91	0.001	J	29.2	5.6	
SW097	DIETHYL PHTHALATE	10/9/91	0.003	J	29.2	5.6	
SW097	DIETHYL PHTHALATE	12/17/92	0.002	J	29.2	5.6	
SW097	DIETHYL PHTHALATE	2/26/93	0.002	J	29.2	5.6	
SW097	DIETHYL PHTHALATE	3/24/93	0.001	J	29.2	5.6	
SW00196	DI-n-BUTYL PHTHALATE	5/29/96	0.006	J	3.65	3.65	
SW00196	DI-n-BUTYL PHTHALATE	9/8/97	0.0014	J,B	3.65	3.65	
SW00196	DI-n-BUTYL PHTHALATE	1/15/98	0.0032	J	3.65	3.65	
SW00196	DI-n-BUTYL PHTHALATE	12/21/98	0.002	J	3.65	3.65	
SW00196	DI-n-BUTYL PHTHALATE	11/1/99	0.002	JB	3.65	3.65	
SW00196	DI-n-BUTYL PHTHALATE	7/24/00	0.001	JB	3.65	3.65	
SW00296	DI-n-BUTYL PHTHALATE	1/15/98	0.0025	J	3.65	3.65	
SW00396	DI-n-BUTYL PHTHALATE	12/21/98	0.002	J	3.65	3.65	
SW00396	DI-n-BUTYL PHTHALATE	4/12/99	0.001	JB	3.65	3.65	
SW00396	DI-n-BUTYL PHTHALATE	11/1/99	0.001	JB	3.65	3.65	
SW097	DI-n-BUTYL PHTHALATE	10/9/89	0.001	J	3.65	3.65	
SW00196	ETHYLBENZENE	5/29/96	0.0002	J	3.65	0.7	
SW00196	ETHYLBENZENE	6/16/97	0.00068	J	3.65	0.7	
SW00196	ETHYLBENZENE	1/18/99	0.003		3.65	0.7	
SW00196	ETHYLBENZENE	2/9/99	0.003		3.65	0.7	
SW00196	ETHYLBENZENE	3/29/99	0.0024		3.65	0.7	
SW00196	ETHYLBENZENE	11/1/99	0.003		3.65	0.7	
SW00196	ETHYLBENZENE	6/19/00	0.0008	J	3.65	0.7	
SW00196	ETHYLBENZENE	7/11/00	0.0004	J	3.65	0.7	
SW00196	ETHYLBENZENE	12/4/00	0.0003	J	3.65	0.7	
SW00196	ETHYLBENZENE	3/19/01	0.0001	J	3.65	0.7	
SW00196	ETHYLBENZENE	6/12/01	0.001		3.65	0.7	
SW00196	ETHYLBENZENE	9/24/01	0.00036	J	3.65	0.7	
SW00296	ETHYLBENZENE	10/30/96	0.0049		3.65	0.7	
SW00296	ETHYLBENZENE	11/20/96	0.0032		3.65	0.7	
SW00296	ETHYLBENZENE	1/20/97	0.00069	J	3.65	0.7	
SW00296	ETHYLBENZENE	10/8/97	0.0014		3.65	0.7	
SW00296	ETHYLBENZENE	12/8/97	0.011		3.65	0.7	
SW00296	ETHYLBENZENE	1/15/98	0.0037		3.65	0.7	
SW00396	ETHYLBENZENE	8/13/97	0.0062		3.65	0.7	
SW00396	ETHYLBENZENE	9/8/97	0.0063		3.65	0.7	
SW00396	ETHYLBENZENE	10/8/97	0.0097		3.65	0.7	
SW00396	ETHYLBENZENE	10/15/97	0.0083		3.65	0.7	
SW00396	ETHYLBENZENE	11/10/97	0.012		3.65	0.7	
SW00396	ETHYLBENZENE	12/8/97	0.0094		3.65	0.7	
SW00396	ETHYLBENZENE	1/15/98	0.012		3.65	0.7	
SW00396	ETHYLBENZENE	12/21/98	0.007		3.65	0.7	
SW00396	ETHYLBENZENE	1/18/99	0.004		3.65	0.7	
SW00396	ETHYLBENZENE	2/9/99	0.005		3.65	0.7	
SW00396	ETHYLBENZENE	3/29/99	0.0044		3.65	0.7	
SW00396	ETHYLBENZENE	4/12/99	0.006		3.65	0.7	
SW00396	ETHYLBENZENE	11/1/99	0.004		3.65	0.7	
SW097	ETHYLBENZENE	6/16/88	0.006		3.65	0.7	
SW097	ETHYLBENZENE	5/19/89	0.012		3.65	0.7	

Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW097	ETHYLBENZENE	7/7/89	0.008		3.65	0.7	
SW097	ETHYLBENZENE	8/2/89	0.011		3.65	0.7	
SW097	ETHYLBENZENE	10/9/89	0.004	J	3.65	0.7	
SW097	ETHYLBENZENE	11/7/89	0.007		3.65	0.7	
SW097	ETHYLBENZENE	12/5/89	0.009		3.65	0.7	
SW097	ETHYLBENZENE	1/12/90	0.012		3.65	0.7	
SW097	ETHYLBENZENE	2/13/90	0.001	J	3.65	0.7	
SW097	ETHYLBENZENE	3/23/90	0.007		3.65	0.7	
SW097	ETHYLBENZENE	5/3/90	0.013		3.65	0.7	
SW097	ETHYLBENZENE	6/5/90	0.018		3.65	0.7	
SW097	ETHYLBENZENE	7/6/90	0.013		3.65	0.7	
SW097	ETHYLBENZENE	8/2/90	0.015		3.65	0.7	
SW097	ETHYLBENZENE	9/6/90	0.014		3.65	0.7	
SW097	ETHYLBENZENE	10/4/90	0.019		3.65	0.7	
SW097	ETHYLBENZENE	11/13/90	0.014		3.65	0.7	
SW097	ETHYLBENZENE	4/3/91	0.013		3.65	0.7	
SW097	ETHYLBENZENE	5/2/91	0.014		3.65	0.7	
SW097	ETHYLBENZENE	6/19/91	0.014		3.65	0.7	
SW097	ETHYLBENZENE	7/29/91	0.018		3.65	0.7	
SW097	ETHYLBENZENE	8/28/91	0.017		3.65	0.7	
SW097	ETHYLBENZENE	9/25/91	0.016		3.65	0.7	
SW097	ETHYLBENZENE	10/9/91	0.015		3.65	0.7	
SW097	ETHYLBENZENE	12/17/92	0.009		3.65	0.7	
SW097	ETHYLBENZENE	1/25/93	0.016		3.65	0.7	
SW097	ETHYLBENZENE	2/26/93	0.014		3.65	0.7	
SW097	ETHYLBENZENE	3/24/93	0.016		3.65	0.7	
SW10795	ETHYLBENZENE	7/3/95	0.009		3.65	0.7	
SW00196	FLUORENE	11/17/98	0.002	J	1.46	0.28	
SW00196	FLUORENE	12/21/98	0.003	J	1.46	0.28	
SW00196	FLUORENE	1/18/99	0.002	J	1.46	0.28	
SW00196	FLUORENE	2/9/99	0.002	J	1.46	0.28	
SW00196	FLUORENE	3/29/99	0.002	J	1.46	0.28	
SW00196	FLUORENE	11/1/99	0.002	J	1.46	0.28	
SW00196	FLUORENE	7/24/00	0.002	J	1.46	0.28	
SW00196	FLUORENE	8/21/00	0.001	J	1.46	0.28	
SW00296	FLUORENE	12/8/97	0.003	J	1.46	0.28	
SW00396	FLUORENE	10/8/97	0.0018	J	1.46	0.28	
SW00396	FLUORENE	12/8/97	0.0028	J	1.46	0.28	
SW00396	FLUORENE	1/15/98	0.003	J	1.46	0.28	
SW00396	FLUORENE	11/17/98	0.002	J	1.46	0.28	
SW00396	FLUORENE	12/21/98	0.003	J	1.46	0.28	
SW00396	FLUORENE	1/18/99	0.002	J	1.46	0.28	
SW00396	FLUORENE	2/9/99	0.002	J	1.46	0.28	
SW00396	FLUORENE	3/29/99	0.0021	J	1.46	0.28	
SW00396	FLUORENE	4/12/99	0.002	J	1.46	0.28	
SW00396	FLUORENE	11/1/99	0.002	J	1.46	0.28	
SW097	FLUORENE	5/19/89	0.001	J	1.46	0.28	
SW097	FLUORENE	10/9/89	0.001	J	1.46	0.28	
SW097	FLUORENE	10/4/90	0.002	J	1.46	0.28	
SW097	FLUORENE	4/3/91	0.002	J	1.46	0.28	
SW097	FLUORENE	10/9/91	0.003	J	1.46	0.28	
SW097	FLUORENE	12/17/92	0.002	J	1.46	0.28	
SW097	FLUORENE	1/25/93	0.002	J	1.46	0.28	
SW097	FLUORENE	2/26/93	0.003	J	1.46	0.28	
SW097	FLUORENE	3/24/93	0.003	J	1.46	0.28	
SW00196	HEXACHLOROBUTADIENE	12/4/00	0.0001	BJ	0.00109	0.01	
SW00196	METHYLENE CHLORIDE	5/29/96	0.002	B	0.0114	0.0047	
SW00196	METHYLENE CHLORIDE	11/20/96	0.00083	J	0.0114	0.0047	
SW00196	METHYLENE CHLORIDE	6/16/97	0.00045	J,B	0.0114	0.0047	
SW00196	METHYLENE CHLORIDE	10/8/97	0.00075	J	0.0114	0.0047	
SW00196	METHYLENE CHLORIDE	1/18/99	0.003		0.0114	0.0047	
SW00196	METHYLENE CHLORIDE	2/9/99	0.003		0.0114	0.0047	
SW00196	METHYLENE CHLORIDE	3/29/99	0.00058	JB	0.0114	0.0047	
SW00196	METHYLENE CHLORIDE	11/1/99	0.0002	JB	0.0114	0.0047	
SW00196	METHYLENE CHLORIDE	6/19/00	0.0002	BJ	0.0114	0.0047	
SW00196	METHYLENE CHLORIDE	7/11/00	0.0003	BJ	0.0114	0.0047	
SW00196	METHYLENE CHLORIDE	12/4/00	0.0002	BJ	0.0114	0.0047	
SW00196	METHYLENE CHLORIDE	3/19/01	0.0002	JB	0.0114	0.0047	
SW00196	METHYLENE CHLORIDE	6/12/01	0.001		0.0114	0.0047	
SW00296	METHYLENE CHLORIDE	10/30/96	0.0011		0.0114	0.0047	
SW00296	METHYLENE CHLORIDE	11/20/96	0.00075	J	0.0114	0.0047	
SW00296	METHYLENE CHLORIDE	1/20/97	0.0011	B	0.0114	0.0047	
SW00296	METHYLENE CHLORIDE	10/15/97	0.0017		0.0114	0.0047	

Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW00296	METHYLENE CHLORIDE	12/8/97	0.00038	J,B	0.0114	0.0047	
SW00396	METHYLENE CHLORIDE	10/15/97	0.0033		0.0114	0.0047	
SW00396	METHYLENE CHLORIDE	1/18/99	0.004		0.0114	0.0047	
SW00396	METHYLENE CHLORIDE	2/9/99	0.002		0.0114	0.0047	
SW00396	METHYLENE CHLORIDE	3/29/99	0.0011	B	0.0114	0.0047	
SW00396	METHYLENE CHLORIDE	4/12/99	0.0006	JB	0.0114	0.0047	
SW00396	METHYLENE CHLORIDE	11/1/99	0.0003	JB	0.0114	0.0047	
SW097	METHYLENE CHLORIDE	6/16/88	**0.013**		**0.0114**	**0.0047**	
SW097	METHYLENE CHLORIDE	4/6/89	0.003	J	0.0114	0.0047	
SW097	METHYLENE CHLORIDE	6/20/89	**0.015**		**0.0114**	**0.0047**	
SW097	METHYLENE CHLORIDE	7/7/89	0.002	J	0.0114	0.0047	
SW097	METHYLENE CHLORIDE	1/12/90	0.004	J	0.0114	0.0047	
SW097	METHYLENE CHLORIDE	2/13/90	**0.19**	B	**0.0114**	**0.0047**	
SW097	METHYLENE CHLORIDE	5/3/90	0.003	JB	0.0114	0.0047	
SW097	METHYLENE CHLORIDE	6/5/90	**0.005**	B	0.0114	**0.0047**	
SW097	METHYLENE CHLORIDE	7/6/90	0.003	JB	0.0114	0.0047	
SW097	METHYLENE CHLORIDE	8/2/90	**0.005**	B	0.0114	**0.0047**	
SW097	METHYLENE CHLORIDE	9/6/90	0.01	B	0.0114	0.0047	
SW097	METHYLENE CHLORIDE	5/2/91	0.003	J	0.0114	0.0047	
SW097	METHYLENE CHLORIDE	6/19/91	0.004	J	0.0114	0.0047	
SW097	METHYLENE CHLORIDE	7/29/91	**0.006**	B	0.0114	**0.0047**	
SW097	METHYLENE CHLORIDE	10/9/91	**0.037**	B	**0.0114**	**0.0047**	
SW097	METHYLENE CHLORIDE	12/17/92	0.004	J	0.0114	0.0047	
SW10795	METHYLENE CHLORIDE	7/3/95	0.0005	J	0.0114	0.0047	
SW00196	NAPHTHALENE	5/29/96	0.002	J	0.73	0.028	
SW00196	NAPHTHALENE	10/8/97	0.014		0.73	0.028	
SW00196	NAPHTHALENE	11/17/98	0.006	J	0.73	0.028	
SW00196	NAPHTHALENE	12/21/98	0.006	J	0.73	0.028	
SW00196	NAPHTHALENE	1/18/99	0.009		0.73	0.028	
SW00196	NAPHTHALENE	2/9/99	0.005		0.73	0.028	
SW00196	NAPHTHALENE	3/29/99	0.0108	B	0.73	0.028	
SW00196	NAPHTHALENE	11/1/99	0.002	J	0.73	0.028	
SW00196	NAPHTHALENE	6/19/00	0.006		0.73	0.028	
SW00196	NAPHTHALENE	7/11/00	0.001	B	0.73	0.028	
SW00196	NAPHTHALENE	7/24/00	0.002	J	0.73	0.028	
SW00196	NAPHTHALENE	12/4/00	0.001	B	0.73	0.028	
SW00196	NAPHTHALENE	3/19/01	0.011	B	0.73	0.028	
SW00196	NAPHTHALENE	6/12/01	0.025	B	0.73	0.028	
SW00196	NAPHTHALENE	9/24/01	0.013		0.73	0.028	
SW00196	NAPHTHALENE	12/3/01	0.004		0.73	0.028	
SW00296	NAPHTHALENE	9/8/97	0.0014		0.73	0.028	
SW00296	NAPHTHALENE	10/8/97	0.001		0.73	0.028	
SW00296	NAPHTHALENE	12/8/97	**0.036**	J	0.73	**0.028**	
SW00296	NAPHTHALENE	1/15/98	0.0011		0.73	0.028	
SW00396	NAPHTHALENE	8/13/97	0.013		0.73	0.028	
SW00396	NAPHTHALENE	9/8/97	0.012		0.73	0.028	
SW00396	NAPHTHALENE	10/8/97	0.03		0.73	0.028	
SW00396	NAPHTHALENE	10/15/97	0.0229		0.73	0.028	
SW00396	NAPHTHALENE	10/15/97	0.0201		0.73	0.028	
SW00396	NAPHTHALENE	11/10/97	0.016	B	0.73	0.028	
SW00396	NAPHTHALENE	12/8/97	**0.037**		0.73	**0.028**	
SW00396	NAPHTHALENE	12/8/97	0.016		0.73	0.028	
SW00396	NAPHTHALENE	1/15/98	**0.041**		0.73	**0.028**	
SW00396	NAPHTHALENE	11/17/98	0.006	J	0.73	0.028	
SW00396	NAPHTHALENE	12/21/98	0.027		0.73	0.028	
SW00396	NAPHTHALENE	1/18/99	0.011		0.73	0.028	
SW00396	NAPHTHALENE	2/9/99	0.024		0.73	0.028	
SW00396	NAPHTHALENE	3/29/99	0.0198	B	0.73	0.028	
SW00396	NAPHTHALENE	4/12/99	0.021		0.73	0.028	
SW00396	NAPHTHALENE	11/1/99	0.014	B	0.73	0.028	
SW097	NAPHTHALENE	4/6/89	0.009	J	0.73	0.028	
SW097	NAPHTHALENE	5/19/89	0.01		0.73	0.028	
SW097	NAPHTHALENE	10/9/89	0.006	J	0.73	0.028	
SW097	NAPHTHALENE	10/4/90	0.026		0.73	0.028	
SW097	NAPHTHALENE	4/3/91	0.014		0.73	0.028	
SW097	NAPHTHALENE	10/9/91	0.022		0.73	0.028	
SW097	NAPHTHALENE	12/17/92	0.019		0.73	0.028	
SW097	NAPHTHALENE	1/25/93	0.014		0.73	0.028	
SW097	NAPHTHALENE	2/26/93	0.02		0.73	0.028	
SW097	NAPHTHALENE	3/24/93	0.025		0.73	0.028	
SW10795	NAPHTHALENE	7/3/95	0.016		0.73	0.028	
SW00196	PENTACHLOROPHENOL	2/9/99	0.001	J	0.07	0.05	PQL
SW00196	PENTACHLOROPHENOL	11/1/99	0.007	J	0.07	0.05	PQL

Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW00196	PHENOL	5/29/96	0.005	J	21.9	2.56	
SW00196	PHENOL	7/24/00	0.0006	J	21.9	2.56	
SW097	PHENOL	5/19/89	0.002	J	21.9	2.56	
SW00196	STYRENE	12/4/00	0.003		7.3	0.1	
SW00196	TETRACHLOROETHENE	11/1/99	0.0002	JB	0.00164	0.001	
SW097	TETRACHLOROETHENE	4/6/89	**0.002**	J	**0.00164**	**0.001**	
SW097	TETRACHLOROETHENE	5/19/89	0.001	J	0.00164	0.001	
SW097	TETRACHLOROETHENE	5/3/90	0.001	J	0.00164	0.001	
SW097	TETRACHLOROETHENE	6/5/90	0.001	J	0.00164	0.001	
SW00196	TOLUENE	5/29/96	0.0002	J	7.3	1	
SW00196	TOLUENE	11/1/99	0.0009	JB	7.3	1	
SW00196	TOLUENE	6/19/00	0.0005	J	7.3	1	
SW00196	TOLUENE	7/11/00	0.0003	J	7.3	1	
SW00196	TOLUENE	12/4/00	0.0005	J	7.3	1	
SW00196	TOLUENE	3/19/01	0.0004	J	7.3	1	
SW00196	TOLUENE	6/12/01	0.0007	J	7.3	1	
SW00196	TOLUENE	9/24/01	0.00044	J	7.3	1	
SW00296	TOLUENE	10/8/97	0.00023	J	7.3	1	
SW00296	TOLUENE	12/8/97	0.0015		7.3	1	
SW00296	TOLUENE	1/15/98	0.00058	J	7.3	1	
SW00396	TOLUENE	10/8/97	0.0013		7.3	1	
SW00396	TOLUENE	10/15/97	0.0014		7.3	1	
SW00396	TOLUENE	11/10/97	0.0013		7.3	1	
SW00396	TOLUENE	12/8/97	0.0014		7.3	1	
SW00396	TOLUENE	1/15/98	0.0011		7.3	1	
SW00396	TOLUENE	12/21/98	0.0008	J	7.3	1	
SW00396	TOLUENE	3/29/99	0.00066	J	7.3	1	
SW00396	TOLUENE	4/12/99	0.0008	J	7.3	1	
SW00396	TOLUENE	11/1/99	0.001	B	7.3	1	
SW097	TOLUENE	6/16/88	0.002	J	7.3	1	
SW097	TOLUENE	4/6/89	0.021		7.3	1	
SW097	TOLUENE	5/19/89	0.012		7.3	1	
SW097	TOLUENE	6/20/89	0.019		7.3	1	
SW097	TOLUENE	7/7/89	0.019		7.3	1	
SW097	TOLUENE	8/2/89	0.032		7.3	1	
SW097	TOLUENE	10/9/89	0.019		7.3	1	
SW097	TOLUENE	11/7/89	0.028		7.3	1	
SW097	TOLUENE	12/5/89	0.032		7.3	1	
SW097	TOLUENE	1/12/90	0.044		7.3	1	
SW097	TOLUENE	2/13/90	0.006		7.3	1	
SW097	TOLUENE	3/23/90	0.04		7.3	1	
SW097	TOLUENE	5/3/90	0.078		7.3	1	
SW097	TOLUENE	6/5/90	0.088		7.3	1	
SW097	TOLUENE	7/6/90	0.062		7.3	1	
SW097	TOLUENE	8/2/90	0.063		7.3	1	
SW097	TOLUENE	9/6/90	0.056		7.3	1	
SW097	TOLUENE	10/4/90	0.079		7.3	1	
SW097	TOLUENE	11/13/90	0.047		7.3	1	
SW097	TOLUENE	4/3/91	0.026		7.3	1	
SW097	TOLUENE	5/2/91	0.028		7.3	1	
SW097	TOLUENE	6/19/91	0.043		7.3	1	
SW097	TOLUENE	7/29/91	0.055		7.3	1	
SW097	TOLUENE	8/28/91	0.046		7.3	1	
SW097	TOLUENE	9/25/91	0.039		7.3	1	
SW097	TOLUENE	10/9/91	0.036		7.3	1	
SW097	TOLUENE	12/17/92	0.008		7.3	1	
SW097	TOLUENE	1/25/93	0.011		7.3	1	
SW097	TOLUENE	2/26/93	0.01		7.3	1	
SW097	TOLUENE	3/24/93	0.01		7.3	1	
SW10795	TOLUENE	7/3/95	0.033		7.3	1	
SW00196	TOTAL XYLENES	5/29/96	0.002		73	10	
SW00196	TOTAL XYLENES	1/20/97	0.00025	J	73	10	
SW00196	TOTAL XYLENES	12/21/98	0.002		73	10	
SW00196	TOTAL XYLENES	1/18/99	0.002		73	10	
SW00196	TOTAL XYLENES	2/9/99	0.002		73	10	
SW00196	TOTAL XYLENES	3/29/99	0.0021	J	73	10	
SW00196	TOTAL XYLENES	11/1/99	0.001		73	10	
SW00196	TOTAL XYLENES	12/4/00	0.003		73	10	
SW00196	TOTAL XYLENES	3/19/01	0.003		73	10	
SW00196	TOTAL XYLENES	6/12/01	0.002		73	10	
SW00196	TOTAL XYLENES	9/24/01	0.0023		73	10	
SW00296	TOTAL XYLENES	10/30/96	0.0019		73	10	
SW00296	TOTAL XYLENES	11/20/96	0.0014		73	10	

Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW00296	TOTAL XYLENES	12/8/97	0.0037		73	10	
SW00296	TOTAL XYLENES	1/15/98	0.00076	J	73	10	
SW00396	TOTAL XYLENES	8/13/97	0.013		73	10	
SW00396	TOTAL XYLENES	9/8/97	0.014		73	10	
SW00396	TOTAL XYLENES	10/8/97	0.003		73	10	
SW00396	TOTAL XYLENES	10/15/97	0.0015		73	10	
SW00396	TOTAL XYLENES	11/10/97	0.0036		73	10	
SW00396	TOTAL XYLENES	12/8/97	0.0032		73	10	
SW00396	TOTAL XYLENES	1/15/98	0.0028		73	10	
SW00396	TOTAL XYLENES	12/21/98	0.007		73	10	
SW00396	TOTAL XYLENES	1/18/99	0.004		73	10	
SW00396	TOTAL XYLENES	2/9/99	0.003		73	10	
SW00396	TOTAL XYLENES	3/29/99	0.0034		73	10	
SW00396	TOTAL XYLENES	4/12/99	0.004		73	10	
SW00396	TOTAL XYLENES	11/1/99	0.002		73	10	
SW097	TOTAL XYLENES	6/16/88	0.004	J	73	10	
SW097	TOTAL XYLENES	4/6/89	0.005		73	10	
SW097	TOTAL XYLENES	5/19/89	0.004	J	73	10	
SW097	TOTAL XYLENES	6/20/89	0.003	J	73	10	
SW097	TOTAL XYLENES	7/7/89	0.003	J	73	10	
SW097	TOTAL XYLENES	8/2/89	0.012		73	10	
SW097	TOTAL XYLENES	11/7/89	0.007	J	73	10	
SW097	TOTAL XYLENES	12/5/89	0.004		73	10	
SW097	TOTAL XYLENES	1/12/90	0.011		73	10	
SW097	TOTAL XYLENES	2/13/90	0.001	J	73	10	
SW097	TOTAL XYLENES	3/23/90	0.025	J	73	10	
SW097	TOTAL XYLENES	5/3/90	0.012		73	10	
SW097	TOTAL XYLENES	6/5/90	0.015		73	10	
SW097	TOTAL XYLENES	7/6/90	0.013		73	10	
SW097	TOTAL XYLENES	8/2/90	0.016		73	10	
SW097	TOTAL XYLENES	9/6/90	0.015		73	10	
SW097	TOTAL XYLENES	10/4/90	0.02		73	10	
SW097	TOTAL XYLENES	11/13/90	0.016		73	10	
SW097	TOTAL XYLENES	4/3/91	0.014		73	10	
SW097	TOTAL XYLENES	5/2/91	0.014		73	10	
SW097	TOTAL XYLENES	6/19/91	0.016		73	10	
SW097	TOTAL XYLENES	7/29/91	0.027		73	10	
SW097	TOTAL XYLENES	8/28/91	0.024		73	10	
SW097	TOTAL XYLENES	9/25/91	0.018		73	10	
SW097	TOTAL XYLENES	10/9/91	0.019		73	10	
SW097	TOTAL XYLENES	12/17/92	0.009		73	10	
SW097	TOTAL XYLENES	1/25/93	0.014		73	10	
SW097	TOTAL XYLENES	2/26/93	0.014		73	10	
SW097	TOTAL XYLENES	3/24/93	0.014		73	10	
SW10795	TOTAL XYLENES	7/3/95	0.009		73	10	
SW00196	trans-1,2-DICHLOROETHENE	11/1/99	0.0001	J	0.329	0.1	
SW00396	trans-1,2-DICHLOROETHENE	4/12/99	0.0001	J	0.329	0.1	
SW00396	trans-1,2-DICHLOROETHENE	11/1/99	0.0001	J	0.329	0.1	
SW00196	TRICHLOROETHENE	11/1/99	0.0006	J	0.00774	0.0027	
SW00196	TRICHLOROETHENE	6/19/00	0.0004	J	0.00774	0.0027	
SW00196	TRICHLOROETHENE	7/11/00	0.0002	J	0.00774	0.0027	
SW00196	TRICHLOROETHENE	12/4/00	0.0002	J	0.00774	0.0027	
SW00196	TRICHLOROETHENE	3/19/01	0.0001	J	0.00774	0.0027	
SW00196	TRICHLOROETHENE	6/12/01	0.0003	J	0.00774	0.0027	
SW00296	TRICHLOROETHENE	12/8/97	0.00087	J	0.00774	0.0027	
SW00296	TRICHLOROETHENE	1/15/98	0.00043	J	0.00774	0.0027	
SW00396	TRICHLOROETHENE	10/8/97	0.00055	J	0.00774	0.0027	
SW00396	TRICHLOROETHENE	10/15/97	0.00059	J	0.00774	0.0027	
SW00396	TRICHLOROETHENE	12/8/97	0.0007	J	0.00774	0.0027	
SW00396	TRICHLOROETHENE	1/15/98	0.00091	J	0.00774	0.0027	
SW00396	TRICHLOROETHENE	4/12/99	0.0005	J	0.00774	0.0027	
SW00396	TRICHLOROETHENE	11/1/99	0.0007	J	0.00774	0.0027	
SW097	TRICHLOROETHENE	4/6/89	0.002	J	0.00774	0.0027	
SW097	TRICHLOROETHENE	5/19/89	0.001	J	0.00774	0.0027	
SW097	TRICHLOROETHENE	8/2/89	0.001	J	0.00774	0.0027	
SW097	TRICHLOROETHENE	10/9/89	**0.012**		**0.00774**	**0.0027**	
SW097	TRICHLOROETHENE	2/13/90	0.004	J	0.00774	0.0027	
SW097	TRICHLOROETHENE	3/23/90	0.002	J	0.00774	0.0027	
SW097	TRICHLOROETHENE	5/3/90	0.002	J	0.00774	0.0027	
SW097	TRICHLOROETHENE	6/5/90	0.002	J	0.00774	0.0027	
SW097	TRICHLOROETHENE	7/6/90	0.001	J	0.00774	0.0027	
SW097	TRICHLOROETHENE	8/2/90	0.002	J	0.00774	0.0027	
SW097	TRICHLOROETHENE	9/6/90	0.001	J	0.00774	0.0027	

Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW097	TRICHLOROETHENE	10/4/90	0.002	J	0.00774	0.0027	
SW097	TRICHLOROETHENE	11/13/90	0.002	J	0.00774	0.0027	
SW097	TRICHLOROETHENE	4/3/91	0.001	J	0.00774	0.0027	
SW097	TRICHLOROETHENE	7/29/91	0.002	J	0.00774	0.0027	
SW097	TRICHLOROETHENE	8/28/91	0.002	J	0.00774	0.0027	
SW097	VINYL ACETATE	2/13/90	0.049		36.5	NS	
SW00196	VINYL CHLORIDE	9/13/96	**0.002**		0.002	0.002	
SW00196	VINYL CHLORIDE	11/20/96	**0.0017**	J	0.002	0.002	
SW00196	VINYL CHLORIDE	10/8/97	**0.0024**		**0.002**	**0.002**	
SW00196	VINYL CHLORIDE	12/8/97	**0.0028**		**0.002**	**0.002**	
SW00196	VINYL CHLORIDE	11/1/99	**0.002**		0.002	0.002	
SW00196	VINYL CHLORIDE	6/19/00	**0.002**	J	0.002	0.002	
SW00196	VINYL CHLORIDE	7/11/00	**0.002**	J	0.002	0.002	
SW00196	VINYL CHLORIDE	12/4/00	**0.001**	J	0.002	0.002	
SW00196	VINYL CHLORIDE	3/19/01	**0.0007**	J	0.002	0.002	
SW00196	VINYL CHLORIDE	6/12/01	**0.001**		0.002	0.002	
SW00196	VINYL CHLORIDE	9/24/01	**0.00084**	J	0.002	0.002	
SW00296	VINYL CHLORIDE	9/13/96	**0.003**		**0.002**	**0.002**	
SW00296	VINYL CHLORIDE	10/30/96	**0.0029**		**0.002**	**0.002**	
SW00296	VINYL CHLORIDE	11/20/96	**0.0024**		**0.002**	**0.002**	
SW00296	VINYL CHLORIDE	1/20/97	**0.0032**		**0.002**	**0.002**	
SW00296	VINYL CHLORIDE	2/19/97	**0.0024**		**0.002**	**0.002**	
SW00296	VINYL CHLORIDE	4/23/97	**0.0032**		**0.002**	**0.002**	
SW00296	VINYL CHLORIDE	10/8/97	**0.0022**		**0.002**	**0.002**	
SW00296	VINYL CHLORIDE	12/8/97	**0.0028**		**0.002**	**0.002**	
SW00296	VINYL CHLORIDE	1/15/98	**0.003**		**0.002**	**0.002**	
SW00396	VINYL CHLORIDE	8/13/97	0.0017		0.002	0.002	
SW00396	VINYL CHLORIDE	10/8/97	**0.0022**		**0.002**	**0.002**	
SW00396	VINYL CHLORIDE	10/15/97	0.0018		0.002	0.002	
SW00396	VINYL CHLORIDE	12/8/97	**0.0025**		**0.002**	**0.002**	
SW00396	VINYL CHLORIDE	4/12/99	0.002		0.002	0.002	
SW00396	VINYL CHLORIDE	11/1/99	**0.003**		**0.002**	**0.002**	
SW097	VINYL CHLORIDE	4/6/89	**0.03**	J	**0.002**	**0.002**	
SW097	VINYL CHLORIDE	8/2/89	0.002	J	0.002	0.002	
SW097	VINYL CHLORIDE	5/3/90	**0.004**	J	**0.002**	**0.002**	
SW097	VINYL CHLORIDE	7/6/90	**0.005**	J	**0.002**	**0.002**	
SW097	VINYL CHLORIDE	9/6/90	**0.003**	J	**0.002**	**0.002**	
SW097	VINYL CHLORIDE	10/9/91	**0.008**	J	**0.002**	**0.002**	
SW097	VINYL CHLORIDE	12/17/92	**0.011**		**0.002**	**0.002**	
Bold face type indicates the analyte was detected above the Surface Water standard or the Preliminary Remediation Goal (PRG)							
NS - No Standard							

Inorganic Detections in Surface Water at or Near the Seep Discharge							
SW Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW00196	ALUMINUM	11/17/98	0.0526	E	36.5	0.087	dissolved
SW00196	ALUMINUM	12/21/98	0.0756		36.5	0.087	dissolved
SW00196	ALUMINUM	1/18/99	0.0718		36.5	0.087	dissolved
SW00196	ALUMINUM	2/9/99	0.0333	E	36.5	0.087	dissolved
SW00196	ALUMINUM	3/29/99	0.0358		36.5	0.087	dissolved
SW00196	ALUMINUM	11/1/99	**0.163**		36.5	**0.087**	dissolved
SW097	ALUMINUM	4/6/89	**0.372**		36.5	**0.087**	dissolved
SW097	ALUMINUM	5/19/89	**3.51**		36.5	**0.087**	dissolved
SW097	ALUMINUM	6/20/89	**21.3**		36.5	**0.087**	dissolved
SW097	ALUMINUM	7/7/89	**1.3**		36.5	**0.087**	dissolved
SW097	ALUMINUM	8/2/89	**1.88**		36.5	**0.087**	dissolved
SW097	ALUMINUM	10/9/89	**0.378**		36.5	**0.087**	dissolved
SW097	ALUMINUM	12/5/89	**0.767**		36.5	**0.087**	dissolved
SW097	ALUMINUM	1/12/90	**4.09**		36.5	**0.087**	dissolved
SW097	ALUMINUM	2/13/90	**26.9**		36.5	**0.087**	dissolved
SW097	ALUMINUM	3/23/90	**8.1**		36.5	**0.087**	dissolved
SW097	ALUMINUM	5/3/90	**1.5**		36.5	**0.087**	dissolved
SW097	ALUMINUM	8/2/90	**1.35**		36.5	**0.087**	dissolved
SW097	ALUMINUM	9/6/90	**1.52**		36.5	**0.087**	dissolved
SW097	ALUMINUM	10/4/90	**0.318**		36.5	**0.087**	dissolved
SW097	ALUMINUM	11/13/90	**0.0927**		36.5	**0.087**	dissolved
SW097	ALUMINUM	4/3/91	**0.197**		36.5	**0.087**	dissolved
SW097	ALUMINUM	5/2/91	**0.952**		36.5	**0.087**	dissolved
SW097	ALUMINUM	6/19/91	0.077		36.5	0.087	dissolved
SW097	ALUMINUM	8/28/91	0.0626		36.5	0.087	dissolved
SW097	ALUMINUM	9/25/91	0.044		36.5	0.087	dissolved
SW097	ALUMINUM	10/9/91	0.029		36.5	0.087	dissolved
SW097	ALUMINUM	12/17/92	**0.394**		36.5	**0.087**	dissolved
SW097	ALUMINUM	1/25/93	**0.31**		36.5	**0.087**	dissolved
SW097	ALUMINUM	2/26/93	**3.88**		36.5	**0.087**	dissolved
SW097	ALUMINUM	4/19/93	0.0552	B	36.5	0.087	dissolved
SW10795	ALUMINUM	7/3/95	**1.57**		36.5	**0.087**	dissolved
SW00196	ANTIMONY	2/9/99	0.00041	BN	0.0146	0.01	PQL
SW00196	ANTIMONY	3/29/99	0.00098	B	0.0146	0.01	PQL
SW00196	ANTIMONY	11/1/99	0.00081	B	0.0146	0.01	PQL
SW097	ANTIMONY	11/7/89	**0.0448**	J	**0.0146**	**0.01**	PQL tot rec
SW097	ANTIMONY	3/23/90	**0.0604**		**0.0146**	**0.01**	PQL tot rec
SW097	ANTIMONY	5/3/90	**0.0727**		**0.0146**	**0.01**	PQL tot rec
SW097	ANTIMONY	8/2/90	**0.0212**	B	**0.0146**	**0.01**	PQL tot rec
SW097	ANTIMONY	9/6/90	**0.0323**	B	**0.0146**	**0.01**	PQL tot rec
SW097	ANTIMONY	9/25/91	**0.023**		**0.0146**	**0.01**	PQL tot rec
SW097	ANTIMONY	10/9/91	**0.015**		0.0146	**0.01**	PQL tot rec
SW097	ANTIMONY	2/26/93	**0.032**		**0.0146**	**0.01**	PQL tot rec
SW00196	ARSENIC	11/1/99	0.0021	B	0.05	0.005	PQL estimated
SW097	ARSENIC	5/19/89	0.0019	J	0.05	0.005	PQL estimated
SW097	ARSENIC	6/20/89	0.0041	J	0.05	0.005	PQL estimated
SW097	ARSENIC	3/23/90	0.002	J	0.05	0.005	PQL estimated
SW097	ARSENIC	8/2/90	0.003	B	0.05	0.005	PQL estimated
SW097	ARSENIC	9/6/90	0.003	B	0.05	0.005	PQL estimated
SW097	ARSENIC	10/4/90	0.0027	B	0.05	0.005	PQL estimated
SW097	ARSENIC	11/13/90	0.0024		0.05	0.005	PQL estimated
SW097	ARSENIC	12/3/90	0.0029	BWN	0.05	0.005	PQL estimated
SW097	ARSENIC	4/3/91	0.0022		0.05	0.005	PQL estimated
SW097	ARSENIC	5/2/91	0.0023		0.05	0.005	PQL estimated
SW097	ARSENIC	6/19/91	0.002		0.05	0.005	PQL estimated
SW097	ARSENIC	7/29/91	0.0008		0.05	0.005	PQL estimated
SW097	ARSENIC	12/17/92	0.0015		0.05	0.005	PQL estimated
SW097	ARSENIC	2/26/93	0.002		0.05	0.005	PQL estimated
SW097	ARSENIC	3/24/93	0.0014		0.05	0.005	PQL estimated
SW097	ARSENIC	4/19/93	0.0014	B	0.05	0.005	PQL estimated
SW00196	BARIUM	11/17/98	**0.724**		2.56	**0.49**	tot rec
SW00196	BARIUM	12/21/98	**0.807**		2.56	**0.49**	tot rec
SW00196	BARIUM	1/18/99	**0.593**		2.56	**0.49**	tot rec
SW00196	BARIUM	2/9/99	**0.744**		2.56	**0.49**	tot rec
SW00196	BARIUM	3/29/99	**0.726**		2.56	**0.49**	tot rec
SW00196	BARIUM	11/1/99	**0.712**		2.56	**0.49**	tot rec
SW097	BARIUM	6/16/88	**0.6**		2.56	**0.49**	tot rec

SW Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW097	BARIUM	4/6/89	**0.692**		2.56	**0.49**	tot rec
SW097	BARIUM	5/19/89	**0.67**		2.56	**0.49**	tot rec
SW097	BARIUM	6/20/89	**1.06**		2.56	**0.49**	tot rec
SW097	BARIUM	7/7/89	**0.629**		2.56	**0.49**	tot rec
SW097	BARIUM	8/2/89	0.00069		2.56	0.49	tot rec
SW097	BARIUM	10/9/89	**0.728**		2.56	**0.49**	tot rec
SW097	BARIUM	11/7/89	**0.627**		2.56	**0.49**	tot rec
SW097	BARIUM	12/5/89	**0.654**		2.56	**0.49**	tot rec
SW097	BARIUM	1/12/90	**0.78**		2.56	**0.49**	tot rec
SW097	BARIUM	2/13/90	**1.55**		2.56	**0.49**	tot rec
SW097	BARIUM	3/23/90	**0.802**		2.56	**0.49**	tot rec
SW097	BARIUM	5/3/90	**0.656**		2.56	**0.49**	tot rec
SW097	BARIUM	6/5/90	**0.589**		2.56	**0.49**	tot rec
SW097	BARIUM	7/6/90	**0.552**		2.56	**0.49**	tot rec
SW097	BARIUM	8/2/90	0.297	E	2.56	0.49	tot rec
SW097	BARIUM	9/6/90	**0.592**	E	2.56	**0.49**	tot rec
SW097	BARIUM	10/4/90	**0.58**		2.56	**0.49**	tot rec
SW097	BARIUM	11/13/90	**0.577**		2.56	**0.49**	tot rec
SW097	BARIUM	12/3/90	0.0545	B	2.56	0.49	tot rec
SW097	BARIUM	4/3/91	**0.564**		2.56	**0.49**	tot rec
SW097	BARIUM	5/2/91	**0.638**		2.56	**0.49**	tot rec
SW097	BARIUM	6/19/91	**0.54**		2.56	**0.49**	tot rec
SW097	BARIUM	7/29/91	**0.512**		2.56	**0.49**	tot rec
SW097	BARIUM	7/29/91	**0.532**		2.56	**0.49**	tot rec
SW097	BARIUM	8/28/91	**0.548**		2.56	**0.49**	tot rec
SW097	BARIUM	9/25/91	**0.53**		2.56	**0.49**	tot rec
SW097	BARIUM	10/9/91	**0.55**		2.56	**0.49**	tot rec
SW097	BARIUM	10/9/91	**0.5**		2.56	**0.49**	tot rec
SW097	BARIUM	12/17/92	**0.62**		2.56	**0.49**	tot rec
SW097	BARIUM	1/25/93	**0.593**		2.56	**0.49**	tot rec
SW097	BARIUM	2/26/93	**0.759**		2.56	**0.49**	tot rec
SW097	BARIUM	3/24/93	**0.64**		2.56	**0.49**	tot rec
SW097	BARIUM	4/19/93	**0.528**		2.56	**0.49**	tot rec
SW10795	BARIUM	7/3/95	**0.643**		2.56	**0.49**	tot rec
SW00196	BERYLLIUM	11/17/98	0.00006	B	0.005	0.005	PQL
SW00196	BERYLLIUM	2/9/99	0.00006	B	0.005	0.005	PQL
SW00196	BERYLLIUM	3/29/99	0.00006	B	0.005	0.005	PQL
SW00196	BERYLLIUM	11/1/99	0.0001	B	0.005	0.005	PQL
SW097	BERYLLIUM	4/6/89	**0.0058**		**0.005**	**0.005**	PQL
SW097	BERYLLIUM	10/4/90	**0.0057**		**0.005**	**0.005**	PQL
SW097	BERYLLIUM	12/17/92	0.0014		0.005	0.005	PQL
SW097	BERYLLIUM	2/26/93	0.001		0.005	0.005	PQL
SW10795	BERYLLIUM	7/3/95	0.00051	B	0.005	0.004	PQL
SW00196	CADMIUM	11/1/99	0.00052	B	0.0183	0.005	PQL
SW097	CADMIUM	2/13/90	**0.0076**		0.0183	**0.005**	PQL dissolved
SW097	CADMIUM	3/23/90	0.0034	J	0.0183	0.005	PQL dissolved
SW097	CADMIUM	8/2/90	0.0039	B	0.0183	0.005	PQL dissolved
SW097	CADMIUM	9/6/90	**0.0054**		0.0183	**0.005**	PQL dissolved
SW097	CADMIUM	6/19/91	**0.0078**		0.0183	**0.005**	PQL dissolved
SW00196	CHROMIUM	11/17/98	0.0118		54.8	0.05	tot rec
SW00196	CHROMIUM	12/21/98	0.0014	B	54.8	0.05	tot rec
SW00196	CHROMIUM	1/18/99	0.00084	B	54.8	0.05	tot rec
SW00196	CHROMIUM	2/9/99	0.004		54.8	0.05	tot rec
SW00196	CHROMIUM	3/29/99	0.0033	N	54.8	0.05	tot rec
SW00196	CHROMIUM	11/1/99	0.00096	B	54.8	0.05	tot rec
SW097	CHROMIUM	6/20/89	0.0215		54.8	0.05	tot rec
SW097	CHROMIUM	2/13/90	0.0296		54.8	0.05	tot rec
SW097	CHROMIUM	3/23/90	0.0113		54.8	0.05	tot rec
SW097	CHROMIUM	8/2/90	0.0267		54.8	0.05	tot rec
SW097	CHROMIUM	9/6/90	0.0218		54.8	0.05	tot rec
SW097	CHROMIUM	12/17/92	0.0079		54.8	0.05	tot rec
SW097	CHROMIUM	1/25/93	0.0031		54.8	0.05	tot rec
SW097	CHROMIUM	2/26/93	0.0135		54.8	0.05	tot rec
SW097	CHROMIUM	3/24/93	0.0063		54.8	0.05	tot rec
SW10795	CHROMIUM	7/3/95	0.0036	B	54.8	0.05	tot rec
SW00196	COBALT	11/17/98	0.0014	B	2.19	NS	
SW00196	COBALT	2/9/99	0.0011	B	2.19	NS	
SW00196	COBALT	3/29/99	0.0011	BE	2.19	NS	

SW Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW00196	COBALT	11/1/99	0.00072	B	2.19	NS	
SW097	COBALT	8/2/90	0.0191	B	2.19	NS	
SW097	COBALT	9/6/90	0.0126	B	2.19	NS	
SW097	COBALT	10/4/90	0.005	B	2.19	NS	
SW097	COBALT	11/13/90	0.0062	B	2.19	NS	
SW097	COBALT	4/3/91	0.004		2.19	NS	
SW097	COBALT	5/2/91	0.0047		2.19	NS	
SW097	COBALT	6/19/91	0.0054		2.19	NS	
SW097	COBALT	9/25/91	0.0036		2.19	NS	
SW097	COBALT	10/9/91	0.0068		2.19	NS	
SW097	COBALT	12/17/92	0.0073		2.19	NS	
SW097	COBALT	1/25/93	0.0075		2.19	NS	
SW097	COBALT	2/26/93	0.009		2.19	NS	
SW097	COBALT	3/24/93	0.0087		2.19	NS	
SW097	COBALT	4/19/93	0.0067	B	2.19	NS	
SW10795	COBALT	7/3/95	0.0044	B	2.19	NS	
SW00196	COPPER	11/17/98	0.0023	B	1.35	0.016	
SW00196	COPPER	12/21/98	0.001	B	1.35	0.016	
SW00196	COPPER	1/18/99	0.0015	B	1.35	0.016	
SW00196	COPPER	2/9/99	0.0014	B	1.35	0.016	
SW00196	COPPER	3/29/99	0.0019	B	1.35	0.016	
SW00196	COPPER	11/1/99	0.00037	B	1.35	0.016	
SW097	COPPER	4/6/89	**0.0304**		1.35	**0.016**	
SW097	COPPER	6/20/89	**0.0451**		1.35	**0.016**	
SW097	COPPER	10/9/89	**0.038**		1.35	**0.016**	
SW097	COPPER	11/7/89	0.0097	B	1.35	0.016	
SW097	COPPER	12/5/89	**0.0283**		1.35	**0.016**	
SW097	COPPER	2/13/90	**0.0949**		1.35	**0.016**	
SW097	COPPER	8/2/90	0.0069	B	1.35	0.016	
SW097	COPPER	9/6/90	0.0128	B	1.35	0.016	
SW097	COPPER	10/4/90	**0.0269**		1.35	**0.016**	
SW097	COPPER	6/19/91	0.012		1.35	0.016	
SW097	COPPER	9/25/91	0.0058		1.35	0.016	
SW097	COPPER	10/9/91	0.002		1.35	0.016	
SW097	COPPER	10/9/91	0.0074		1.35	0.016	
SW097	COPPER	12/17/92	0.0066		1.35	0.016	
SW097	COPPER	2/26/93	0.0064		1.35	0.016	
SW10795	COPPER	7/3/95	0.0142	B	1.35	NS	
SW097	FLUORIDE	8/2/90	0.5		2.19	2	
SW097	FLUORIDE	10/4/90	0.5		2.19	2	
SW097	FLUORIDE	11/13/90	0.63		2.19	2	
SW097	FLUORIDE	4/3/91	0.47		2.19	2	
SW097	FLUORIDE	5/2/91	0.44		2.19	2	
SW097	FLUORIDE	6/19/91	0.51		2.19	2	
SW097	FLUORIDE	7/29/91	0.46		2.19	2	
SW097	FLUORIDE	8/28/91	0.39		2.19	2	
SW097	FLUORIDE	9/25/91	0.46		2.19	2	
SW097	FLUORIDE	10/9/91	0.42		2.19	2	
SW097	FLUORIDE	1/25/93	0.49		2.19	2	
SW097	FLUORIDE	2/26/93	0.54		2.19	2	
SW097	FLUORIDE	3/24/93	0.45		2.19	2	
SW10795	FLUORIDE	7/3/95	0.6		4	2	
SW00196	IRON	11/17/98	**54.9**	N*	**11**	NS	
SW00196	IRON	12/21/98	**69.5**		**11**	NS	
SW00196	IRON	1/18/99	**44.4**		**11**	NS	
SW00196	IRON	2/9/99	**51.9**	E	**11**	NS	
SW00196	IRON	3/29/99	**44.4**		**11**	NS	
SW00196	IRON	11/1/99	**54.1**		**11**	NS	
SW097	IRON	6/16/88	**55.1**		**11**	NS	
SW097	IRON	4/6/89	**68**		**11**	NS	
SW097	IRON	5/19/89	**61.2**		**11**	NS	
SW097	IRON	6/20/89	**84.3**		**11**	NS	
SW097	IRON	7/7/89	**65**		**11**	NS	
SW097	IRON	8/2/89	**67.3**		**11**	NS	
SW097	IRON	10/9/89	**75.2**		**11**	NS	
SW097	IRON	11/7/89	**60.3**		**11**	NS	
SW097	IRON	12/5/89	**75**		**11**	NS	
SW097	IRON	1/12/90	**79.3**		**11**	NS	

SW Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW097	IRON	2/13/90	**155**		**11**	NS	
SW097	IRON	3/23/90	**75.1**		**11**	NS	
SW097	IRON	5/3/90	**68.2**		**11**	NS	
SW097	IRON	6/5/90	**63.5**		**11**	NS	
SW097	IRON	7/6/90	**61.3**		**11**	NS	
SW097	IRON	8/2/90	**66**	N	**11**	NS	
SW097	IRON	9/6/90	**66.8**	E	**11**	NS	
SW097	IRON	10/4/90	**70.1**		**11**	NS	
SW097	IRON	11/13/90	**68.6**		**11**	NS	
SW097	IRON	12/3/90	0.176		11	NS	
SW097	IRON	4/3/91	**75**		**11**	NS	
SW097	IRON	5/2/91	**84.3**		**11**	NS	
SW097	IRON	6/19/91	**68**		**11**	NS	
SW097	IRON	7/29/91	**69.7**		**11**	NS	
SW097	IRON	8/28/91	**74.9**		**11**	NS	
SW097	IRON	9/25/91	**77**		**11**	NS	
SW097	IRON	10/9/91	**81**		**11**	NS	
SW097	IRON	12/17/92	**96.5**		**11**	NS	
SW097	IRON	1/25/93	**96.1**		**11**	NS	
SW097	IRON	2/26/93	**117**		**11**	NS	
SW097	IRON	4/19/93	**77.3**		**11**	NS	
SW10795	IRON	7/3/95	**52.4**		**11**	NS	
SW10795	IRON	7/3/95	0.0295	B	11	NS	
SW00196	LEAD	11/17/98	0.0015	N	No Value	0.01	PQL dissolved
SW00196	LEAD	2/9/99	0.00046	B	No Value	0.01	PQL dissolved
SW00196	LEAD	3/29/99	0.0011	BE	No Value	0.01	PQL dissolved
SW00196	LEAD	11/1/99	0.0024		No Value	0.01	PQL dissolved
SW097	LEAD	4/6/89	**0.0132**		No Value	**0.01**	PQL dissolved
SW097	LEAD	5/19/89	0.0055		No Value	0.01	PQL dissolved
SW097	LEAD	6/20/89	**0.0373**		No Value	**0.01**	PQL dissolved
SW097	LEAD	7/7/89	0.0057		No Value	0.01	PQL dissolved
SW097	LEAD	10/9/89	**0.0234**		No Value	**0.01**	PQL dissolved
SW097	LEAD	1/12/90	**0.0104**		No Value	**0.01**	PQL dissolved
SW097	LEAD	3/23/90	0.0095		No Value	0.01	PQL dissolved
SW097	LEAD	8/2/90	0.0015	B	No Value	0.01	PQL dissolved
SW097	LEAD	9/6/90	0.0061		No Value	0.01	PQL dissolved
SW097	LEAD	10/4/90	0.0028	B	No Value	0.01	PQL dissolved
SW097	LEAD	11/13/90	0.0052		No Value	0.01	PQL dissolved
SW097	LEAD	4/3/91	0.0047		No Value	0.01	PQL dissolved
SW097	LEAD	5/2/91	0.0099		No Value	0.01	PQL dissolved
SW097	LEAD	6/19/91	0.0058		No Value	0.01	PQL dissolved
SW097	LEAD	7/29/91	0.0047		No Value	0.01	PQL dissolved
SW097	LEAD	8/28/91	0.0016		No Value	0.01	PQL dissolved
SW097	LEAD	9/25/91	0.0017		No Value	0.01	PQL dissolved
SW097	LEAD	10/9/91	0.0031	I	No Value	0.01	PQL dissolved
SW097	LEAD	1/25/93	0.0017		No Value	0.01	PQL dissolved
SW097	LEAD	2/26/93	**0.011**		No Value	**0.01**	PQL dissolved
SW097	LEAD	3/24/93	0.0068		No Value	0.01	PQL dissolved
SW10795	LEAD	7/3/95	0.0022	B	No Value	0.01	PQL dissolved
SW00196	LITHIUM	11/17/98	0.0324	B	0.73	NS	
SW00196	LITHIUM	12/21/98	0.037	B	0.73	NS	
SW00196	LITHIUM	1/18/99	0.027	BN	0.73	NS	
SW00196	LITHIUM	2/9/99	0.0427	BE	0.73	NS	
SW00196	LITHIUM	3/29/99	0.0433	B	0.73	NS	
SW00196	LITHIUM	11/1/99	0.0364	B	0.73	NS	
SW097	LITHIUM	4/6/89	0.104		0.73	NS	
SW097	LITHIUM	5/19/89	0.0805		0.73	NS	
SW097	LITHIUM	1/12/90	0.081		0.73	NS	
SW097	LITHIUM	3/23/90	0.111		0.73	NS	
SW097	LITHIUM	8/2/90	0.0413	B	0.73	NS	
SW097	LITHIUM	9/6/90	0.0406	B	0.73	NS	
SW097	LITHIUM	10/4/90	0.0369	B	0.73	NS	
SW097	LITHIUM	11/13/90	0.0442		0.73	NS	
SW097	LITHIUM	4/3/91	0.0368		0.73	NS	
SW097	LITHIUM	5/2/91	0.0441		0.73	NS	
SW097	LITHIUM	6/19/91	0.049		0.73	NS	
SW097	LITHIUM	7/29/91	0.0376		0.73	NS	
SW097	LITHIUM	8/28/91	0.0392		0.73	NS	

SW Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW097	LITHIUM	9/25/91	0.035		0.73	NS	
SW097	LITHIUM	10/9/91	0.036		0.73	NS	
SW097	LITHIUM	1/25/93	0.0461		0.73	NS	
SW097	LITHIUM	2/26/93	0.0464		0.73	NS	
SW097	LITHIUM	4/19/93	0.0507	B	0.73	NS	
SW10795	LITHIUM	7/3/95	0.0519	B	0.73	NS	
SW00196	MANGANESE	11/17/98	1.18	*	1.72	NS	
SW00196	MANGANESE	12/21/98	1.17	*	1.72	NS	
SW00196	MANGANESE	1/18/99	1.16		1.72	NS	
SW00196	MANGANESE	2/9/99	1.3		1.72	NS	
SW00196	MANGANESE	3/29/99	1.21		1.72	NS	
SW00196	MANGANESE	11/1/99	1.39		1.72	NS	
SW097	MANGANESE	6/16/88	**2.3**		**1.72**	NS	
SW097	MANGANESE	4/6/89	1.61		1.72	NS	
SW097	MANGANESE	5/19/89	1.54		1.72	NS	
SW097	MANGANESE	6/20/89	**2.11**		**1.72**	NS	
SW097	MANGANESE	7/7/89	1.72		1.72	NS	
SW097	MANGANESE	8/2/89	**1.8**		**1.72**	NS	
SW097	MANGANESE	10/9/89	**1.96**		**1.72**	NS	
SW097	MANGANESE	11/7/89	1.66		1.72	NS	
SW097	MANGANESE	12/5/89	**1.82**		**1.72**	NS	
SW097	MANGANESE	1/12/90	**1.84**		**1.72**	NS	
SW097	MANGANESE	2/13/90	**2.49**		**1.72**	NS	
SW097	MANGANESE	3/23/90	**2.04**		**1.72**	NS	
SW097	MANGANESE	5/3/90	**1.83**		**1.72**	NS	
SW097	MANGANESE	6/5/90	**1.74**		**1.72**	NS	
SW097	MANGANESE	7/6/90	1.61		1.72	NS	
SW097	MANGANESE	8/2/90	1.66		1.72	NS	
SW097	MANGANESE	9/6/90	1.7	E	1.72	NS	
SW097	MANGANESE	10/4/90	1.71		1.72	NS	
SW097	MANGANESE	11/13/90	1.72		1.72	NS	
SW097	MANGANESE	12/3/90	0.0087	B	1.72	NS	
SW097	MANGANESE	4/3/91	1.32		1.72	NS	
SW097	MANGANESE	5/2/91	1.43		1.72	NS	
SW097	MANGANESE	6/19/91	1.5		1.72	NS	
SW097	MANGANESE	7/29/91	1.43		1.72	NS	
SW097	MANGANESE	8/28/91	1.49		1.72	NS	
SW097	MANGANESE	9/25/91	1.4		1.72	NS	
SW097	MANGANESE	10/9/91	1.4		1.72	NS	
SW097	MANGANESE	12/17/92	1.52		1.72	NS	
SW097	MANGANESE	1/25/93	1.44		1.72	NS	
SW097	MANGANESE	2/26/93	1.51		1.72	NS	
SW097	MANGANESE	4/19/93	1.31		1.72	NS	
SW10795	MANGANESE	7/3/95	1.43		1.72	NS	
SW00196	MERCURY	1/18/99	**0.0012**		0.011	**0.001**	PQL total
SW097	MERCURY	6/16/88	**0.0022**		0.011	**0.001**	PQL total
SW097	MERCURY	4/6/89	0.00038		0.011	0.001	PQL total
SW097	MERCURY	6/20/89	0.00028		0.011	0.001	PQL total
SW097	MERCURY	2/13/90	0.00028		0.011	0.001	PQL total
SW00196	MOLYBDENUM	2/9/99	0.00016	B	0.183	NS	
SW00196	MOLYBDENUM	3/29/99	0.0011	B	0.183	NS	
SW097	MOLYBDENUM	8/2/90	0.0285	B	0.183	NS	
SW097	MOLYBDENUM	9/6/90	0.0138	B	0.183	NS	
SW097	MOLYBDENUM	5/2/91	0.0098		0.183	NS	
SW097	MOLYBDENUM	8/28/91	0.0196		0.183	NS	
SW097	MOLYBDENUM	1/25/93	0.0213		0.183	NS	
SW00196	NICKEL	11/17/98	0.0075	B	0.73	0.123	dissolved
SW00196	NICKEL	12/21/98	0.0026	B	0.73	0.123	dissolved
SW00196	NICKEL	1/18/99	0.0048	B	0.73	0.123	dissolved
SW00196	NICKEL	2/9/99	0.0076	BE	0.73	0.123	dissolved
SW00196	NICKEL	3/29/99	0.0079	BE	0.73	0.123	dissolved
SW00196	NICKEL	11/1/99	0.0046	B	0.73	0.123	dissolved
SW097	NICKEL	4/6/89	0.0294	J	0.73	0.123	dissolved
SW097	NICKEL	5/19/89	0.0241	J	0.73	0.123	dissolved
SW097	NICKEL	6/20/89	0.0173	J	0.73	0.123	dissolved
SW097	NICKEL	10/9/89	0.0114	B	0.73	0.123	dissolved
SW097	NICKEL	8/2/90	0.0146	B	0.73	0.123	dissolved
SW097	NICKEL	9/6/90	0.0115	B	0.73	0.123	dissolved

SW Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW097	NICKEL	5/2/91	0.0161		0.73	0.123	dissolved
SW097	NICKEL	8/28/91	0.031		0.73	0.123	dissolved
SW097	NICKEL	1/25/93	0.0216		0.73	0.123	dissolved
SW097	NICKEL	2/26/93	0.0209		0.73	0.123	dissolved
SW097	NICKEL	3/24/93	0.017		0.73	0.123	dissolved
SW097	NICKEL	4/19/93	0.0143	B	0.73	0.123	dissolved
SW097	NITRATE	9/6/89	0.08		58.4	10	
SW097	NITRATE/NITRITE	4/6/89	0.06		58.4	10	
SW097	NITRATE/NITRITE	9/6/89	0.08		58.4	10	
SW097	NITRATE/NITRITE	10/9/89	0.14		58.4	10	
SW097	NITRATE/NITRITE	2/13/90	0.09		58.4	10	
SW097	NITRATE/NITRITE	4/20/90	0.15		58.4	10	
SW097	NITRATE/NITRITE	6/5/90	0.51		58.4	10	
SW097	NITRATE/NITRITE	12/3/90	1.3		58.4	10	
SW097	NITRATE/NITRITE	4/3/91	0.21		58.4	10	
SW097	NITRATE/NITRITE	5/2/91	0.87		58.4	10	
SW097	NITRATE/NITRITE	6/19/91	0.57		58.4	10	
SW097	NITRATE/NITRITE	7/29/91	0.12		58.4	10	
SW097	NITRATE/NITRITE	10/9/91	0.18		58.4	10	
SW097	NITRITE	8/2/90	0.04		3.65	0.5	
SW097	NITRITE	9/6/90	0.04		3.65	0.5	
SW097	NITRITE	4/3/91	0.044		3.65	0.5	
SW097	NITRITE	5/2/91	0.063		3.65	0.5	
SW097	NITRITE	6/19/91	0.025		3.65	0.5	
SW097	NITRITE	9/25/91	0.031		3.65	0.5	
SW00196	SELENIUM	12/21/98	0.0037		0.183	0.01	PQL
SW00196	SELENIUM	2/9/99	0.0015	B	0.183	0.01	PQL
SW00196	SELENIUM	3/29/99	0.0023	B	0.183	0.01	PQL
SW097	SELENIUM	8/2/90	0.007	W	0.183	0.01	PQL
SW097	SELENIUM	2/26/93	0.0014		0.183	0.01	PQL
SW00196	SILVER	2/9/99	0.00035	B	0.183	0.005	PQL
SW00196	SILVER	3/29/99	0.00066	B	0.183	0.005	PQL
SW097	SILVER	11/7/89	**0.0131**		0.183	**0.005**	PQL
SW097	SILVER	3/23/90	**0.01**		0.183	**0.005**	PQL
SW097	SILVER	8/2/90	**0.0111**		0.183	**0.005**	PQL
SW097	SILVER	9/6/90	**0.0167**		0.183	**0.005**	PQL
SW097	SILVER	10/4/90	**0.0065**	B	0.183	**0.005**	PQL
SW097	SILVER	11/13/90	0.0036		0.183	0.005	PQL
SW097	SILVER	5/2/91	**0.0051**		0.183	**0.005**	PQL
SW097	SILVER	12/17/92	0.0027		0.183	0.005	PQL
SW097	SILVER	2/26/93	0.0044		0.183	0.005	PQL
SW10795	SILVER	7/3/95	**0.0061**	B	0.183	**0.005**	PQL
SW00196	STRONTIUM	11/17/98	1.01		2.19	NS	
SW00196	STRONTIUM	12/21/98	1		2.19	NS	
SW00196	STRONTIUM	1/18/99	0.929		2.19	NS	
SW00196	STRONTIUM	2/9/99	1.08		2.19	NS	
SW00196	STRONTIUM	3/29/99	1.05		2.19	NS	
SW00196	STRONTIUM	11/1/99	1.03		2.19	NS	
SW097	STRONTIUM	6/16/88	1.2		2.19	NS	
SW097	STRONTIUM	5/19/89	1.14		2.19	NS	
SW097	STRONTIUM	6/20/89	1.17		2.19	NS	
SW097	STRONTIUM	8/2/89	1.07		2.19	NS	
SW097	STRONTIUM	10/9/89	1.26		2.19	NS	
SW097	STRONTIUM	11/7/89	1		2.19	NS	
SW097	STRONTIUM	12/5/89	1.21		2.19	NS	
SW097	STRONTIUM	1/12/90	1.15		2.19	NS	
SW097	STRONTIUM	2/13/90	1.37		2.19	NS	
SW097	STRONTIUM	3/23/90	1.35		2.19	NS	
SW097	STRONTIUM	5/3/90	1.14		2.19	NS	
SW097	STRONTIUM	6/5/90	1.03		2.19	NS	
SW097	STRONTIUM	8/2/90	0.893		2.19	NS	
SW097	STRONTIUM	9/6/90	0.91	E	2.19	NS	
SW097	STRONTIUM	10/4/90	0.971		2.19	NS	
SW097	STRONTIUM	11/13/90	0.971		2.19	NS	
SW097	STRONTIUM	12/3/90	0.148	B	2.19	NS	
SW097	STRONTIUM	4/3/91	0.829		2.19	NS	
SW097	STRONTIUM	5/2/91	0.942		2.19	NS	
SW097	STRONTIUM	6/19/91	0.9		2.19	NS	

SW Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW097	STRONTIUM	7/29/91	0.84		2.19	NS	
SW097	STRONTIUM	8/28/91	0.865		2.19	NS	
SW097	STRONTIUM	9/25/91	0.84		2.19	NS	
SW097	STRONTIUM	10/9/91	0.86		2.19	NS	
SW097	STRONTIUM	1/25/93	0.916		2.19	NS	
SW097	STRONTIUM	2/26/93	0.976		2.19	NS	
SW097	STRONTIUM	4/19/93	0.96		2.19	NS	
SW10795	STRONTIUM	7/3/95	1.09		2.19	NS	
SW097	SULFATE	4/6/89	19		No Value	NS	
SW097	SULFATE	6/20/89	9		No Value	NS	
SW097	SULFATE	10/9/89	8		No Value	NS	
SW097	SULFATE	2/13/90	13.8		No Value	NS	
SW097	SULFATE	3/23/90	7		No Value	NS	
SW097	SULFATE	5/3/90	12		No Value	NS	
SW097	SULFATE	12/3/90	13		No Value	NS	
SW097	SULFATE	5/2/91	29.6		No Value	NS	
SW097	SULFATE	8/28/91	7.3		No Value	NS	
SW097	SULFATE	9/25/91	14.5		No Value	NS	
SW097	SULFATE	12/17/92	1.1		No Value	NS	
SW097	SULFATE	1/25/93	0.67		No Value	NS	
SW097	SULFATE	2/26/93	0.46		No Value	NS	
SW10795	SULFATE	7/3/95	1.76		No Value	NS	
SW00196	THALLIUM	1/18/99	0.00082	BN	No Value	0.012	PQL
SW00196	THALLIUM	2/9/99	0.00046	B	No Value	0.012	PQL
SW00196	THALLIUM	3/29/99	0.00076	BE	No Value	0.012	PQL
SW00196	THALLIUM	11/1/99	0.0015	B	No Value	0.012	PQL
SW097	THALLIUM	5/19/89	0.0024	J	No Value	0.012	PQL
SW00196	TIN	2/9/99	0.0017	B	21.9	NS	
SW00196	TIN	3/29/99	0.0006	B	21.9	NS	
SW00196	TIN	11/1/99	0.00088	B	21.9	NS	
SW097	TIN	7/7/89	0.000104		21.9	NS	
SW097	TIN	10/9/89	0.122		21.9	NS	
SW097	TIN	12/5/89	0.107		21.9	NS	
SW097	TIN	2/13/90	0.243		21.9	NS	
SW097	TIN	5/3/90	0.109		21.9	NS	
SW097	TIN	8/2/90	0.108	B	21.9	NS	
SW097	TIN	9/6/90	0.0541	B	21.9	NS	
SW097	TIN	10/4/90	0.306		21.9	NS	
SW097	TIN	11/13/90	0.183	B	21.9	NS	
SW097	TIN	5/2/91	0.0334		21.9	NS	
SW097	TIN	7/29/91	0.0569		21.9	NS	
SW097	TIN	9/25/91	0.022		21.9	NS	
SW097	TIN	10/9/91	0.032		21.9	NS	
SW00196	VANADIUM	11/17/98	0.0042	B	0.256	NS	
SW00196	VANADIUM	12/21/98	0.003	B	0.256	NS	
SW00196	VANADIUM	1/18/99	0.0026	B	0.256	NS	
SW00196	VANADIUM	2/9/99	0.0112	UN	0.256	NS	
SW00196	VANADIUM	11/1/99	0.0029	B	0.256	NS	
SW097	VANADIUM	6/20/89	0.102		0.256	NS	
SW097	VANADIUM	10/9/89	0.0374	B	0.256	NS	
SW097	VANADIUM	11/7/89	0.0357	J	0.256	NS	
SW097	VANADIUM	12/5/89	0.0589		0.256	NS	
SW097	VANADIUM	1/12/90	0.0153		0.256	NS	
SW097	VANADIUM	2/13/90	0.211		0.256	NS	
SW097	VANADIUM	8/2/90	0.0273	B	0.256	NS	
SW097	VANADIUM	9/6/90	0.0272	B	0.256	NS	
SW097	VANADIUM	10/4/90	0.0144	B	0.256	NS	
SW097	VANADIUM	11/13/90	0.0034		0.256	NS	
SW097	VANADIUM	5/2/91	0.0063		0.256	NS	
SW097	VANADIUM	6/19/91	0.005		0.256	NS	
SW097	VANADIUM	9/25/91	0.0056		0.256	NS	
SW097	VANADIUM	10/9/91	0.0031		0.256	NS	
SW097	VANADIUM	12/17/92	0.0093		0.256	NS	
SW097	VANADIUM	1/25/93	0.0154		0.256	NS	
SW097	VANADIUM	2/26/93	0.0193		0.256	NS	
SW097	VANADIUM	3/24/93	0.0096		0.256	NS	
SW10795	VANADIUM	7/3/95	0.0182	B	0.256	NS	
SW00196	ZINC	11/17/98	**0.18**		11	**0.141**	dissolved

SW Station	Compound	Sample Date	Result (mg/l)	Qualifier	PRG (mg/l)	SW Std. (mg/l)	SW Std. Qualifier
SW00196	ZINC	12/21/98	**0.287**	*	11	**0.141**	dissolved
SW00196	ZINC	1/18/99	**0.183**	N*	11	**0.141**	dissolved
SW00196	ZINC	2/9/99	**0.189**		11	**0.141**	dissolved
SW00196	ZINC	3/29/99	**0.195**	N	11	**0.141**	dissolved
SW00196	ZINC	11/1/99	**0.206**		11	**0.141**	dissolved
SW097	ZINC	6/16/88	**8.9**		11	**0.141**	dissolved
SW097	ZINC	4/6/89	**5.14**		11	**0.141**	dissolved
SW097	ZINC	5/19/89	**4.35**		11	**0.141**	dissolved
SW097	ZINC	6/20/89	**6.05**		11	**0.141**	dissolved
SW097	ZINC	7/7/89	**5.04**		11	**0.141**	dissolved
SW097	ZINC	8/2/89	**3.56**		11	**0.141**	dissolved
SW097	ZINC	10/9/89	**4.44**		11	**0.141**	dissolved
SW097	ZINC	11/7/89	**3.11**		11	**0.141**	dissolved
SW097	ZINC	12/5/89	**4.26**		11	**0.141**	dissolved
SW097	ZINC	1/12/90	**3.92**		11	**0.141**	dissolved
SW097	ZINC	2/13/90	**1.84**		11	**0.141**	dissolved
SW097	ZINC	2/13/90	**16**		11	**0.141**	dissolved
SW097	ZINC	3/23/90	**2.64**		11	**0.141**	dissolved
SW097	ZINC	5/3/90	**2.3**		11	**0.141**	dissolved
SW097	ZINC	6/5/90	**1.96**		11	**0.141**	dissolved
SW097	ZINC	7/6/90	**2.08**		11	**0.141**	dissolved
SW097	ZINC	8/2/90	**2.34**		11	**0.141**	dissolved
SW097	ZINC	9/6/90	**2.43**		11	**0.141**	dissolved
SW097	ZINC	10/4/90	**2.36**		11	**0.141**	dissolved
SW097	ZINC	11/13/90	**2.71**		11	**0.141**	dissolved
SW097	ZINC	12/3/90	0.0141	B	11	0.141	dissolved
SW097	ZINC	4/3/91	**2.55**		11	**0.141**	dissolved
SW097	ZINC	5/2/91	**2.63**		11	**0.141**	dissolved
SW097	ZINC	6/19/91	**1.8**		11	**0.141**	dissolved
SW097	ZINC	7/29/91	**2.02**		11	**0.141**	dissolved
SW097	ZINC	8/28/91	**2.22**		11	**0.141**	dissolved
SW097	ZINC	9/25/91	**2.2**		11	**0.141**	dissolved
SW097	ZINC	10/9/91	**2.2**		11	**0.141**	dissolved
SW097	ZINC	12/17/92	**0.857**		11	**0.141**	dissolved
SW097	ZINC	1/25/93	**0.939**		11	**0.141**	dissolved
SW097	ZINC	2/26/93	**2.15**		11	**0.141**	dissolved
SW097	ZINC	3/24/93	**1.2**		11	**0.141**	dissolved
SW097	ZINC	4/19/93	**0.425**		11	**0.141**	dissolved
SW10795	ZINC	7/3/95	0.752		11	0.141	dissolved
Bold face type indicates the analyte was detected above the Surface Water Standard or the							
Preliminary Remediation Goal							
NS -No Standard							

Radionuclide Detections in Surface Water at or Near the Seep Discharge						
SW Station	Compound	Sample Date	Result (pCi/l)	Qualifier	PRG (pCi/l)	SW Std. (pCi/l)
SW097	AMERICIUM-241	4/6/89	0.02		0.145	0.15
SW097	AMERICIUM-241	7/7/89	0.01		0.145	0.15
SW097	AMERICIUM-241	10/9/89	0.01		0.145	0.15
SW097	AMERICIUM-241	11/7/89	0.015		0.145	0.15
SW097	AMERICIUM-241	2/13/90	0.008		0.145	0.15
SW097	AMERICIUM-241	3/23/90	0.005		0.145	0.15
SW097	AMERICIUM-241	4/20/90	0.004		0.145	0.15
SW097	AMERICIUM-241	7/6/90	0.003695	J	0.145	0.15
SW097	AMERICIUM-241	8/2/90	0.01234		0.145	0.15
SW097	AMERICIUM-241	9/6/90	0.02121		0.145	0.15
SW097	AMERICIUM-241	10/4/90	0.012		0.145	0.15
SW097	AMERICIUM-241	5/2/91	0.19		0.145	0.15
SW097	AMERICIUM-241	6/19/91	0.002045	J	0.145	0.15
SW097	AMERICIUM-241	7/29/91	0	J	0.145	0.15
SW097	AMERICIUM-241	9/25/91	0.009	J	0.145	0.15
SW097	AMERICIUM-241	10/9/91	0.007	J	0.145	0.15
SW097	AMERICIUM-241	12/17/92	0.00633	J	0.145	0.15
SW097	AMERICIUM-241	1/25/93	0.002917	J	0.145	0.15
SW097	AMERICIUM-241	2/26/93	0.01992		0.145	0.15
SW097	AMERICIUM-241	3/24/93	0.005674		0.145	0.15
SW097	GROSS ALPHA	6/16/88	0		NV	11
SW097	GROSS ALPHA	4/6/89	6		NV	11
SW097	GROSS ALPHA	5/19/89	**40**		NV	**11**
SW097	GROSS ALPHA	6/20/89	**14**		NV	**11**
SW097	GROSS ALPHA	7/7/89	5		NV	11
SW097	GROSS ALPHA	8/2/89	6		NV	11
SW097	GROSS ALPHA	11/7/89	1.04		NV	11
SW097	GROSS ALPHA	2/13/90	4.6		NV	11
SW097	GROSS ALPHA	4/20/90	2.8		NV	11
SW097	GROSS ALPHA	6/5/90	**8.7**		NV	11
SW097	GROSS ALPHA	7/6/90	1.755	J	NV	11
SW097	GROSS ALPHA	8/2/90	**7.91**		NV	11
SW097	GROSS ALPHA	9/6/90	1.556		NV	11
SW097	GROSS ALPHA	10/4/90	0.9559		NV	11
SW097	GROSS ALPHA	5/2/91	4.8		NV	11
SW097	GROSS ALPHA	6/19/91	2.896		NV	11
SW097	GROSS ALPHA	7/29/91	1.998	J	NV	11
SW097	GROSS ALPHA	9/25/91	4.5		NV	11
SW097	GROSS ALPHA	10/9/91	5.7		NV	11
SW097	GROSS ALPHA	12/17/92	2.353		NV	11
SW097	GROSS ALPHA	1/25/93	0.9161	J	NV	11
SW097	GROSS ALPHA	2/26/93	6.639		NV	11
SW097	GROSS ALPHA	3/24/93	3		NV	11
SW097	GROSS BETA	6/16/88	15.5		NV	19
SW097	GROSS BETA	4/6/89	15		NV	19
SW097	GROSS BETA	5/19/89	**36**		NV	**19**
SW097	GROSS BETA	6/20/89	**35**		NV	**19**
SW097	GROSS BETA	7/7/89	15		NV	19
SW097	GROSS BETA	8/2/89	**28**		NV	**19**
SW097	GROSS BETA	10/9/89	5.7		NV	19
SW097	GROSS BETA	11/7/89	17.4		NV	19
SW097	GROSS BETA	2/13/90	12.4		NV	19
SW097	GROSS BETA	4/20/90	13.9		NV	19
SW097	GROSS BETA	6/5/90	9.7		NV	19
SW097	GROSS BETA	7/6/90	0.5469	J	NV	19
SW097	GROSS BETA	8/2/90	9.328		NV	19
SW097	GROSS BETA	9/6/90	3.753		NV	19
SW097	GROSS BETA	10/4/90	9.231		NV	19
SW097	GROSS BETA	11/13/90	11		NV	19
SW097	GROSS BETA	4/3/91	5.2		NV	19
SW097	GROSS BETA	5/2/91	17		NV	19
SW097	GROSS BETA	6/19/91	6.769		NV	19
SW097	GROSS BETA	6/19/91	9.345		NV	19
SW097	GROSS BETA	7/29/91	6.839		NV	19
SW097	GROSS BETA	9/25/91	9.1		NV	19

SW Station	Compound	Sample Date	Result (pCi/l)	Qualifier	PRG (pCi/l)	SW Std. (pCi/l)
SW097	GROSS BETA	10/9/91	7.1		NV	19
SW097	GROSS BETA	12/17/92	12.67		NV	19
SW097	GROSS BETA	1/25/93	8.425		NV	19
SW097	GROSS BETA	2/26/93	12.69		NV	19
SW097	GROSS BETA	3/24/93	8.94		NV	19
SW097	PLUTONIUM-239/240	6/16/88	**0.166**		**0.151**	**0.15**
SW097	PLUTONIUM-239/240	4/6/89	0.03		0.151	0.15
SW097	PLUTONIUM-239/240	4/6/89	0.005		0.151	0.15
SW097	PLUTONIUM-239/240	5/19/89	0.02		0.151	0.15
SW097	PLUTONIUM-239/240	6/20/89	0.03		0.151	0.15
SW097	PLUTONIUM-239/240	9/6/89	0.005		0.151	0.15
SW097	PLUTONIUM-239/240	11/7/89	0.008		0.151	0.15
SW097	PLUTONIUM-239/240	2/13/90	0.009		0.151	0.15
SW097	PLUTONIUM-239/240	4/20/90	0.006		0.151	0.15
SW097	PLUTONIUM-239/240	6/5/90	0.007		0.151	0.15
SW097	PLUTONIUM-239/240	7/6/90	0.006055	J	0.151	0.15
SW097	PLUTONIUM-239/240	8/2/90	0.001852	J	0.151	0.15
SW097	PLUTONIUM-239/240	9/6/90	0.004335		0.151	0.15
SW097	PLUTONIUM-239/240	10/4/90	0.005873		0.151	0.15
SW097	PLUTONIUM-239/240	5/2/91	0.0012		0.151	0.15
SW097	PLUTONIUM-239/240	6/19/91	0.005923	J	0.151	0.15
SW097	PLUTONIUM-239/240	7/29/91	0.007816	J	0.151	0.15
SW097	PLUTONIUM-239/240	8/28/91	0.003	J	0.151	0.15
SW097	PLUTONIUM-239/240	9/25/91	0.003	J	0.151	0.15
SW097	PLUTONIUM-239/240	10/9/91	0.009	J	0.151	0.15
SW097	PLUTONIUM-239/240	12/17/92	0.01348		0.151	0.15
SW097	PLUTONIUM-239/240	1/25/93	0.003556	J	0.151	0.15
SW097	PLUTONIUM-239/240	2/26/93	0.01606		0.151	0.15
SW097	PLUTONIUM-239/240	3/24/93	0.001	BJ	0.151	0.15
SW097	PLUTONIUM-239/240	3/24/93	0.00276	J	0.151	0.15
SW097	RADIUM-226	4/6/89	**0.5**		**0.161**	5
SW097	RADIUM-226	5/19/89	**0.9**		**0.161**	5
SW097	RADIUM-226	6/20/89	**6.6**		**0.161**	**5**
SW097	RADIUM-226	7/7/89	**0.7**		**0.161**	5
SW097	RADIUM-226	8/2/89	**1**		**0.161**	5
SW097	RADIUM-226	3/23/90	**0.58**		**0.161**	5
SW097	RADIUM-226	8/2/90	**0.4847**	J	**0.161**	5
SW097	RADIUM-226	11/13/90	**1**		**0.161**	5
SW097	RADIUM-228	6/20/89	**5.4**		**0.192**	**5**
SW097	RADIUM-228	11/13/90	**0.86**		**0.192**	5
SW097	STRONTIUM-89,90	4/6/89	**0.9**		**0.852**	8
SW097	STRONTIUM-89,90	5/19/89	0.5		0.852	8
SW097	STRONTIUM-89,90	6/20/89	0.8		0.852	8
SW097	STRONTIUM-89,90	7/7/89	0.8		0.852	8
SW097	STRONTIUM-89,90	8/2/89	**0.9**		**0.852**	8
SW097	STRONTIUM-89,90	9/6/89	**1.07**		**0.852**	8
SW097	STRONTIUM-89,90	10/9/89	**2.21**		**0.852**	8
SW097	STRONTIUM-89,90	12/5/89	**1.17**		**0.852**	8
SW097	STRONTIUM-89,90	3/23/90	**1.18**		**0.852**	8
SW097	STRONTIUM-89,90	4/20/90	**0.95**		**0.852**	8
SW097	STRONTIUM-89,90	6/5/90	**1.71**		**0.852**	8
SW097	STRONTIUM-89,90	7/6/90	**1.295**	X	**0.852**	8
SW097	STRONTIUM-89,90	8/2/90	**1.025**		**0.852**	8
SW097	STRONTIUM-89,90	6/19/91	**1.604**		**0.852**	8
SW097	STRONTIUM-89,90	6/19/91	**1.259**		**0.852**	8
SW097	STRONTIUM-89,90	7/29/91	**1.911**		**0.852**	8
SW097	STRONTIUM-89,90	9/25/91	0.66	J	0.852	8
SW097	STRONTIUM-89,90	10/9/91	**0.93**	J	**0.852**	8
SW097	STRONTIUM-89,90	12/17/92	0.7801	J	0.852	8
SW097	STRONTIUM-89,90	1/25/93	**1.059**		**0.852**	8
SW097	STRONTIUM-89,90	2/26/93	**4.06**		**0.852**	8
SW097	STRONTIUM-89,90	3/24/93	**1.1**		**0.852**	8
SW097	STRONTIUM-90	4/6/89	**1.11**		**0.852**	8
SW097	STRONTIUM-90	7/7/89	0.8		0.852	8
SW097	STRONTIUM-90	11/7/89	**1.18**		**0.852**	8
SW097	STRONTIUM-90	2/13/90	**1.1**		**0.852**	8

SW Station	Compound	Sample Date	Result (pCi/l)	Qualifier	PRG (pCi/l)	SW Std. (pCi/l)
SW097	STRONTIUM-90	9/6/90	0.552		0.852	8
SW097	STRONTIUM-90	10/4/90	0.5442		0.852	8
SW097	STRONTIUM-90	4/3/91	**0.99**		**0.852**	8
SW00196	TRITIUM	11/17/98	290	J	666	500
SW00196	TRITIUM	2/9/99	400		666	500
SW097	TRITIUM	6/16/88	**1280**		**666**	**500**
SW097	TRITIUM	4/6/89	400		666	500
SW097	TRITIUM	5/19/89	270		666	500
SW097	TRITIUM	6/20/89	360		666	500
SW097	TRITIUM	7/7/89	230		666	500
SW097	TRITIUM	8/2/89	**520**		666	**500**
SW097	TRITIUM	9/6/89	340		666	500
SW097	TRITIUM	2/13/90	340		666	500
SW097	TRITIUM	4/20/90	280		666	500
SW097	TRITIUM	6/5/90	500		666	500
SW097	TRITIUM	7/6/90	265.8	J	666	500
SW097	TRITIUM	8/2/90	223.2	J	666	500
SW097	TRITIUM	9/6/90	389.8288		666	500
SW097	TRITIUM	4/3/91	320		666	500
SW097	TRITIUM	5/2/91	390		666	500
SW097	TRITIUM	7/29/91	425.1		666	500
SW097	TRITIUM	8/28/91	250	J	666	500
SW097	TRITIUM	9/25/91	1500		666	500
SW097	TRITIUM	12/17/92	440.7		666	500
SW097	TRITIUM	1/25/93	378.5	J	666	500
SW097	TRITIUM	2/26/93	423.4		666	500
SW097	TRITIUM	3/24/93	196.4	J	666	500
SW00196	URANIUM-233,-234	11/17/98	0.739	J	1.06	10
SW00196	URANIUM-233,-234	12/21/98	0.131	J	1.06	10
SW00196	URANIUM-233,-234	1/18/99	0.23	J	1.06	10
SW00196	URANIUM-233,-234	2/9/99	0.165	J	1.06	10
SW00196	URANIUM-233,-234	3/29/99	0.1127	J	1.06	10
SW00196	URANIUM-233,-234	11/1/99	0.1341	J	1.06	10
SW097	URANIUM-233,-234	6/16/88	**1.72**		**1.06**	10
SW097	URANIUM-233,-234	4/6/89	0.2		1.06	10
SW097	URANIUM-233,-234	5/19/89	3.8		1.06	10
SW097	URANIUM-233,-234	6/20/89	0.3		1.06	10
SW097	URANIUM-233,-234	7/7/89	0.2		1.06	10
SW097	URANIUM-233,-234	8/2/89	0.5		1.06	10
SW097	URANIUM-233,-234	9/6/89	**1.68**		**1.06**	10
SW097	URANIUM-233,-234	10/9/89	0.28		1.06	10
SW097	URANIUM-233,-234	11/7/89	0.28		1.06	10
SW097	URANIUM-233,-234	2/13/90	0.07		1.06	10
SW097	URANIUM-233,-234	6/5/90	0.43		1.06	10
SW097	URANIUM-233,-234	7/6/90	0.114	J	1.06	10
SW097	URANIUM-233,-234	8/2/90	0.1232	J	1.06	10
SW097	URANIUM-233,-234	9/6/90	0.4343		1.06	10
SW097	URANIUM-233,-234	10/4/90	0.2954		1.06	10
SW097	URANIUM-233,-234	6/19/91	0.09539	J	1.06	10
SW097	URANIUM-233,-234	7/29/91	0.05674	J	1.06	10
SW097	URANIUM-233,-234	8/28/91	0.3	J	1.06	10
SW097	URANIUM-233,-234	9/25/91	0.39	J	1.06	10
SW097	URANIUM-233,-234	10/9/91	4.2	B	1.06	10
SW097	URANIUM-233,-234	12/17/92	0.04807	J	1.06	10
SW097	URANIUM-233,-234	2/26/93	0.5784		1.06	10
SW097	URANIUM-233,-234	3/24/93	0.45	BJ	1.06	10
SW097	URANIUM-234	12/3/90	**1.8**		**1.06**	10
SW00196	URANIUM-235	11/17/98	0.039	J	1.01	10
SW097	URANIUM-235	4/6/89	0.07		1.01	10
SW097	URANIUM-235	9/6/89	0.09		1.01	10
SW097	URANIUM-235	10/9/89	0.09		1.01	10
SW097	URANIUM-235	11/7/89	0.19		1.01	10
SW097	URANIUM-235	11/7/89	0.19		1.01	10
SW097	URANIUM-235	2/13/90	0.08		1.01	10
SW097	URANIUM-235	6/5/90	0.05		1.01	10
SW097	URANIUM-235	7/6/90	0.01899	J	1.01	10

SW Station	Compound	Sample Date	Result (pCi/l)	Qualifier	PRG (pCi/l)	SW Std. (pCi/l)
SW097	URANIUM-235	8/2/90	0.03789	J	1.01	10
SW097	URANIUM-235	6/19/91	0.0318	J	1.01	10
SW097	URANIUM-235	7/29/91	0.04189	J	1.01	10
SW097	URANIUM-235	9/25/91	0.084	J	1.01	10
SW097	URANIUM-235	10/9/91	0.078	J	1.01	10
SW097	URANIUM-235	12/17/92	0.05448	J	1.01	10
SW097	URANIUM-235	2/26/93	0.04504	J	1.01	10
SW097	URANIUM-235	3/24/93	0.03	BJ	1.01	10
SW00196	URANIUM-238	11/17/98	0.717	J	0.768	10
SW00196	URANIUM-238	12/21/98	0.075	J	0.768	10
SW00196	URANIUM-238	1/18/99	0.107	J	0.768	10
SW00196	URANIUM-238	2/9/99	0.133	J	0.768	10
SW00196	URANIUM-238	3/29/99	0.1239	J	0.768	10
SW00196	URANIUM-238	11/1/99	0.1815	J	0.768	10
SW097	URANIUM-238	6/16/88	**3.34**		**0.768**	10
SW097	URANIUM-238	4/6/89	0.22		0.768	10
SW097	URANIUM-238	5/19/89	**1.7**		**0.768**	10
SW097	URANIUM-238	6/20/89	0.3		0.768	10
SW097	URANIUM-238	7/7/89	0.1		0.768	10
SW097	URANIUM-238	8/2/89	0.4		0.768	10
SW097	URANIUM-238	9/6/89	**1.31**		**0.768**	10
SW097	URANIUM-238	10/9/89	0.37		0.768	10
SW097	URANIUM-238	11/7/89	0.76		0.768	10
SW097	URANIUM-238	2/13/90	0.3		0.768	10
SW097	URANIUM-238	6/5/90	0.12		0.768	10
SW097	URANIUM-238	7/6/90	0.09497	J	0.768	10
SW097	URANIUM-238	8/2/90	0.1232	J	0.768	10
SW097	URANIUM-238	9/6/90	0.1737		0.768	10
SW097	URANIUM-238	10/4/90	0.04924		0.768	10
SW097	URANIUM-238	6/19/91	0.07838	J	0.768	10
SW097	URANIUM-238	7/29/91	0.09574	J	0.768	10
SW097	URANIUM-238	10/9/91	3		0.768	10
SW097	URANIUM-238	12/17/92	0.04166	J	0.768	10
SW097	URANIUM-238	1/25/93	0.2834	J	0.768	10
SW097	URANIUM-238	2/26/93	0.2228	J	0.768	10
SW097	URANIUM-238	3/24/93	0.1282	J	0.768	10
SW097	URANIUM-238	3/24/93	0.45	BJ	0.768	10
Bold face type indicates the analyte was detected above the Surface Water Standard or the Preliminary Remediation Goal						
NV - No Value						

APPENDIX C
GROUNDWATER QUALITY TIME SERIES PLOTS

Figure C-1
Benzene Concentrations in Unconsolidated Material Groundwater Near the Seep

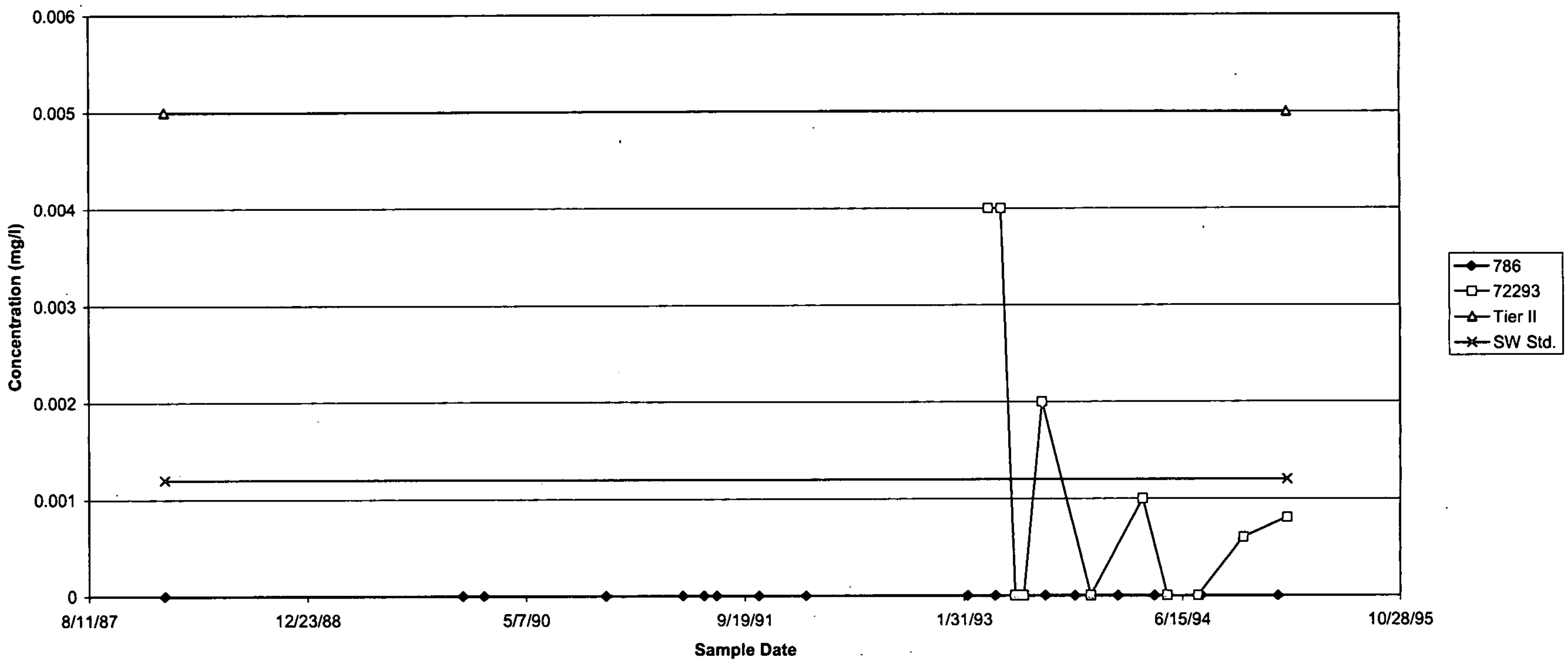


Figure C-2
Chloroethane Concentrations in Unconsolidated Material Groundwater Near the Seep

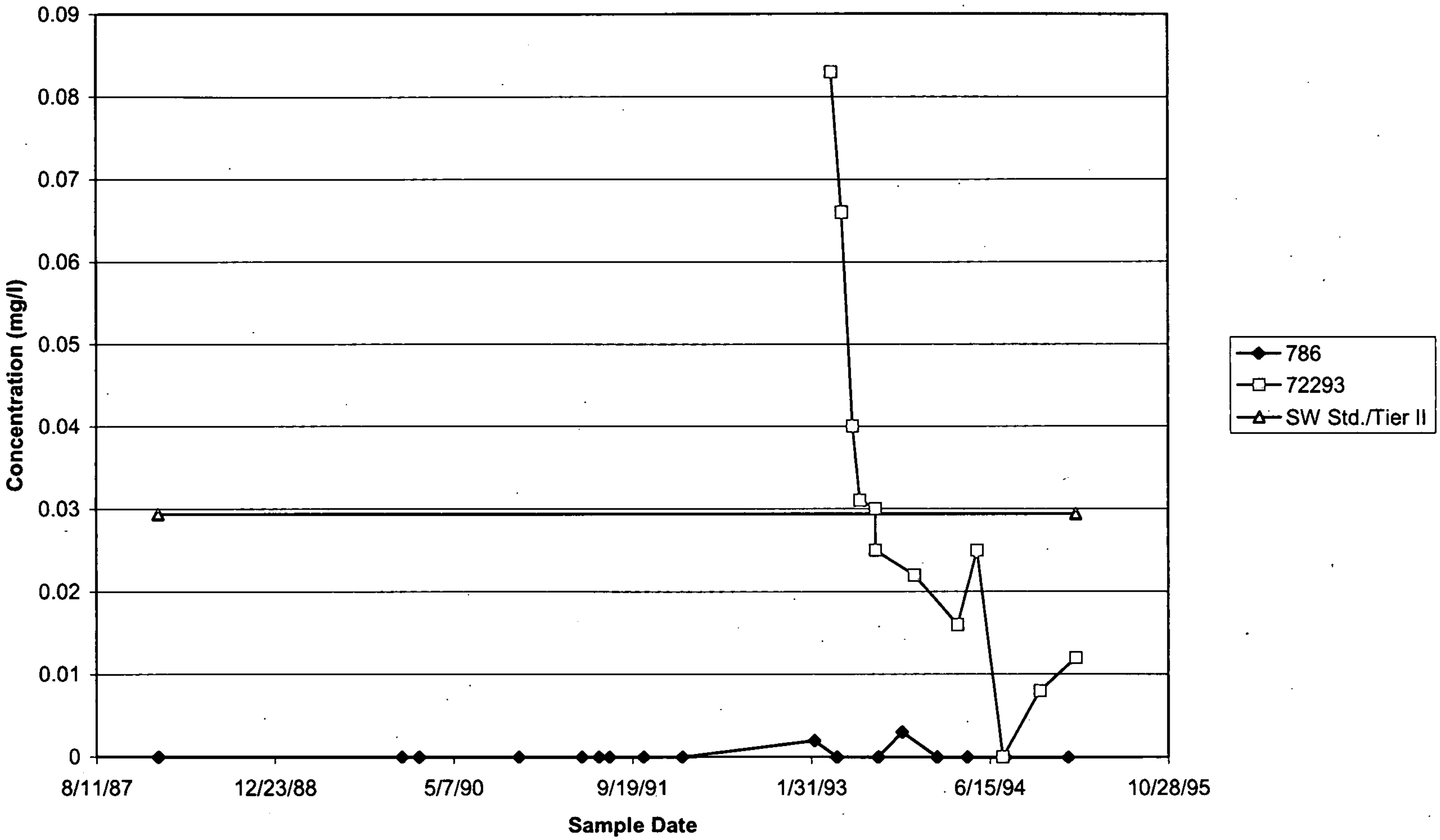


Figure C-3
Naphthalene Concentrations in Unconsolidated Material Groundwater Near the Seep

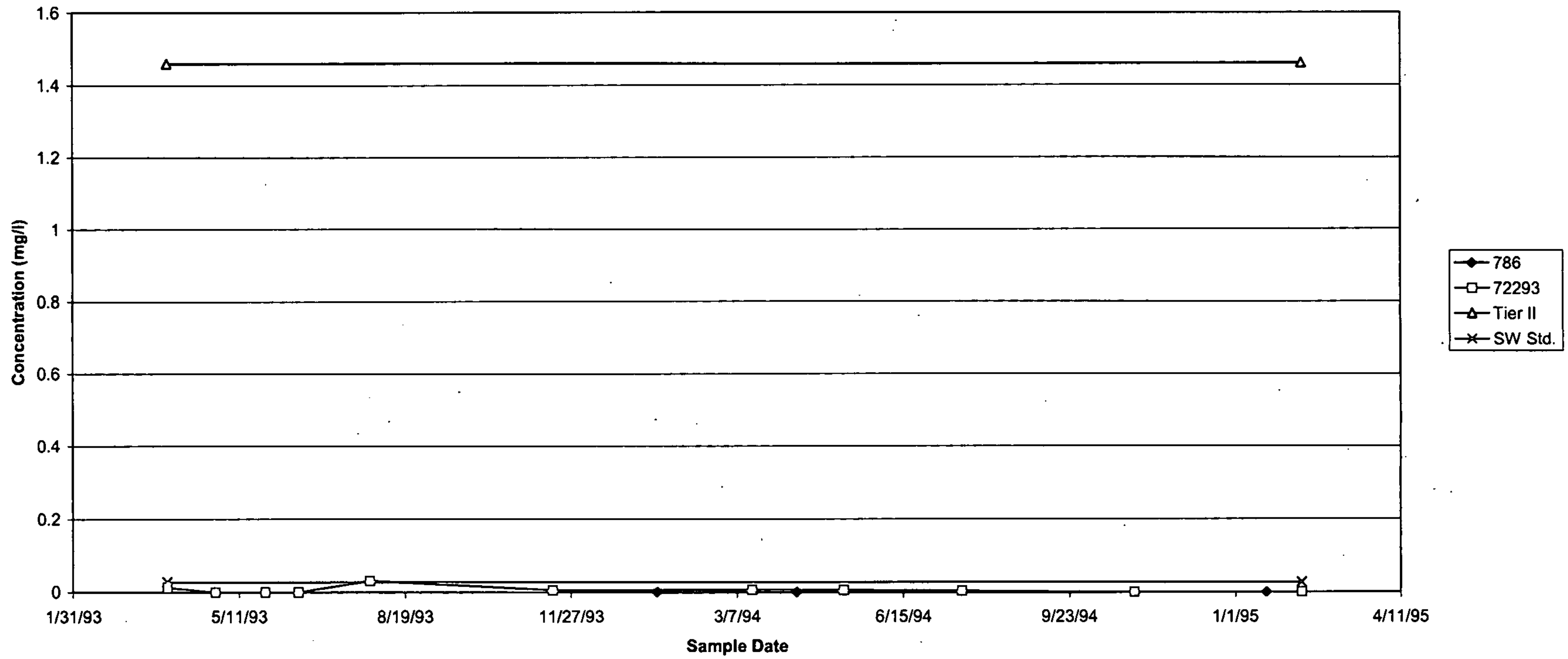


Figure C-4
Vinyl Chloride Concentrations in Unconsolidated Material Groundwater Near the Seep

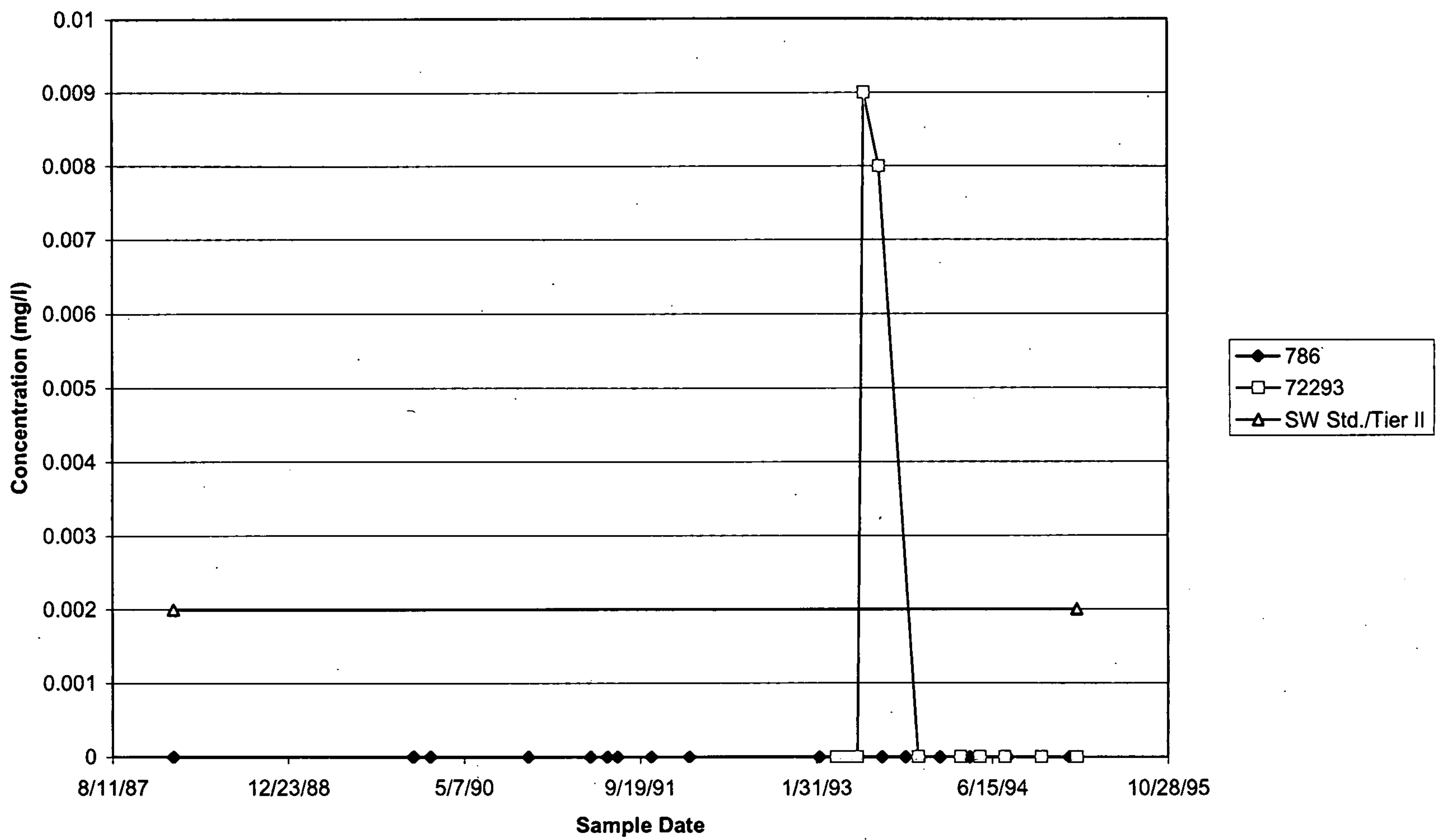


Figure C-5
Aluminum Concentrations in Unconsolidated Material Groundwater Near the Seep

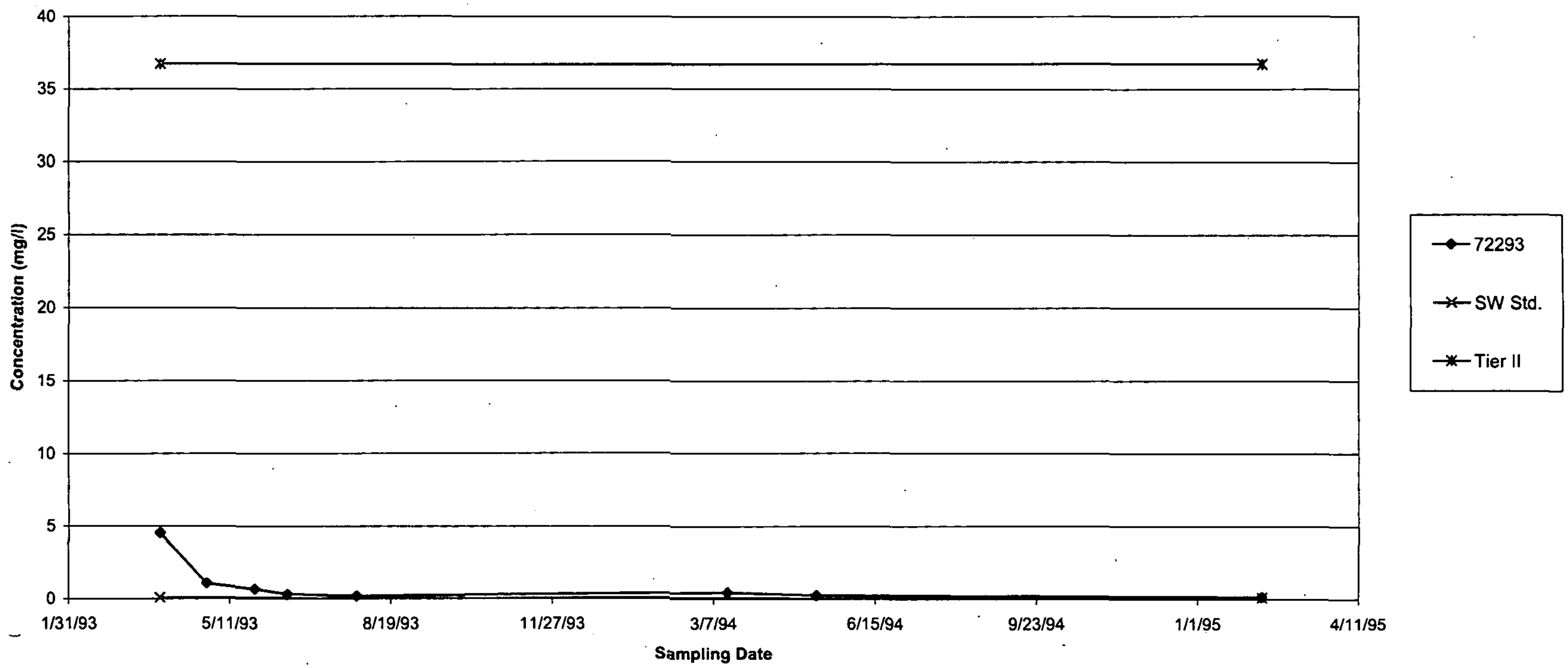


Figure C-6
Arsenic Concentrations in Unconsolidated Material Groundwater Near the Seep

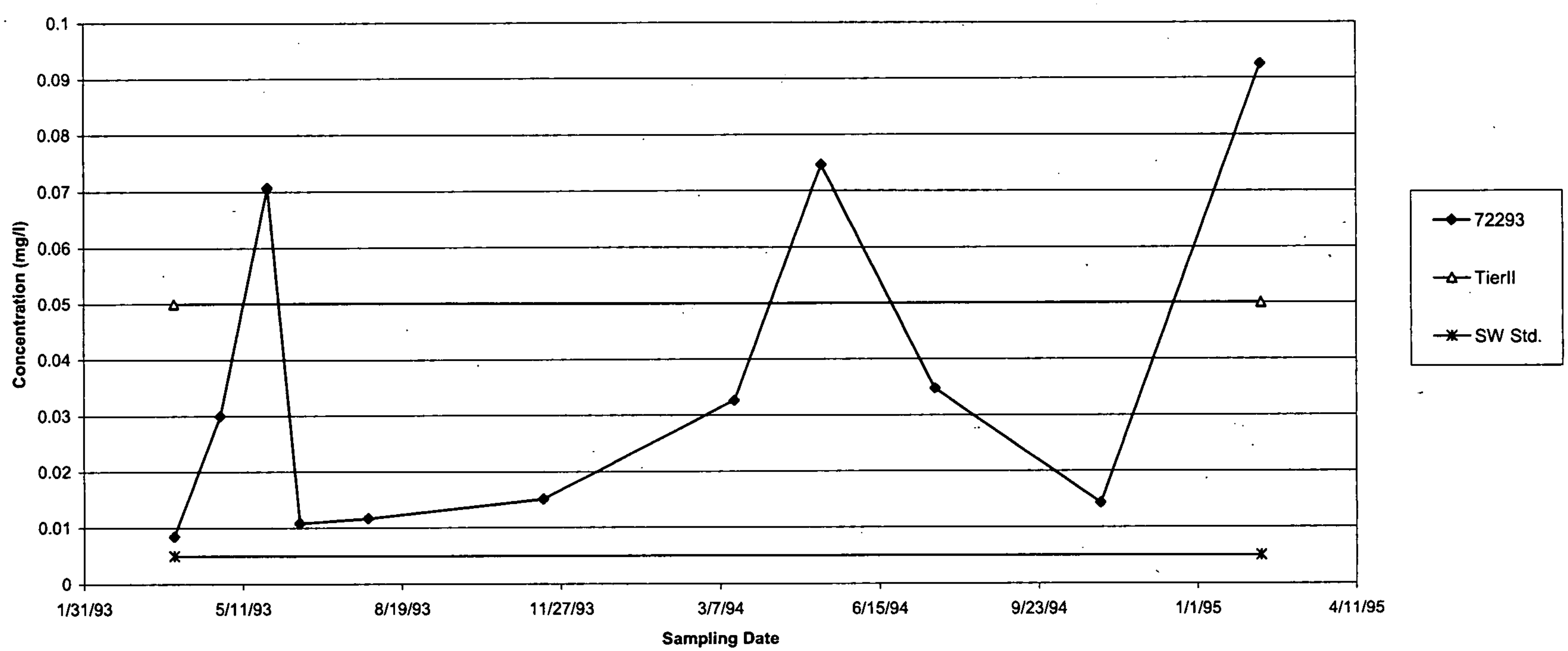


Figure C-7
Barium Concentrations in Unconsolidated Material Groundwater Near the Seep

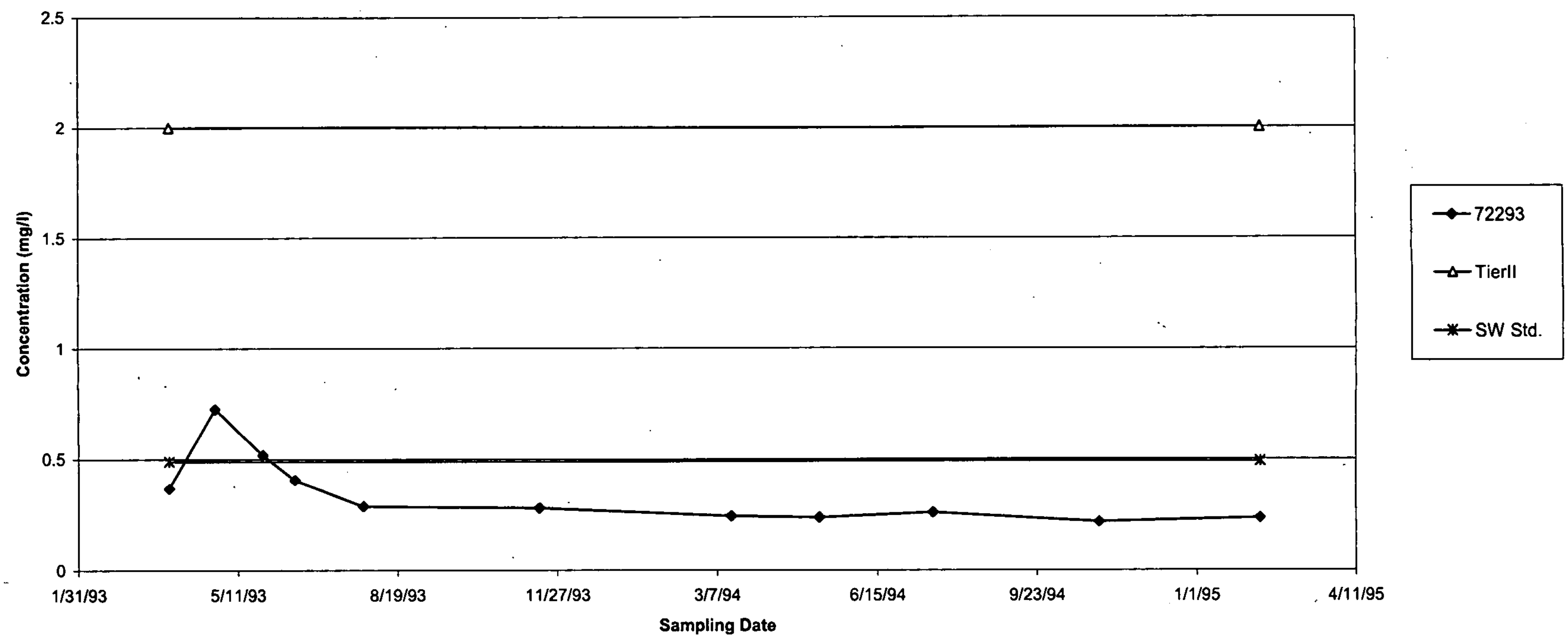


Figure C-8
Lead Concentrations in Unconsolidated Material Groundwater Near the Seep

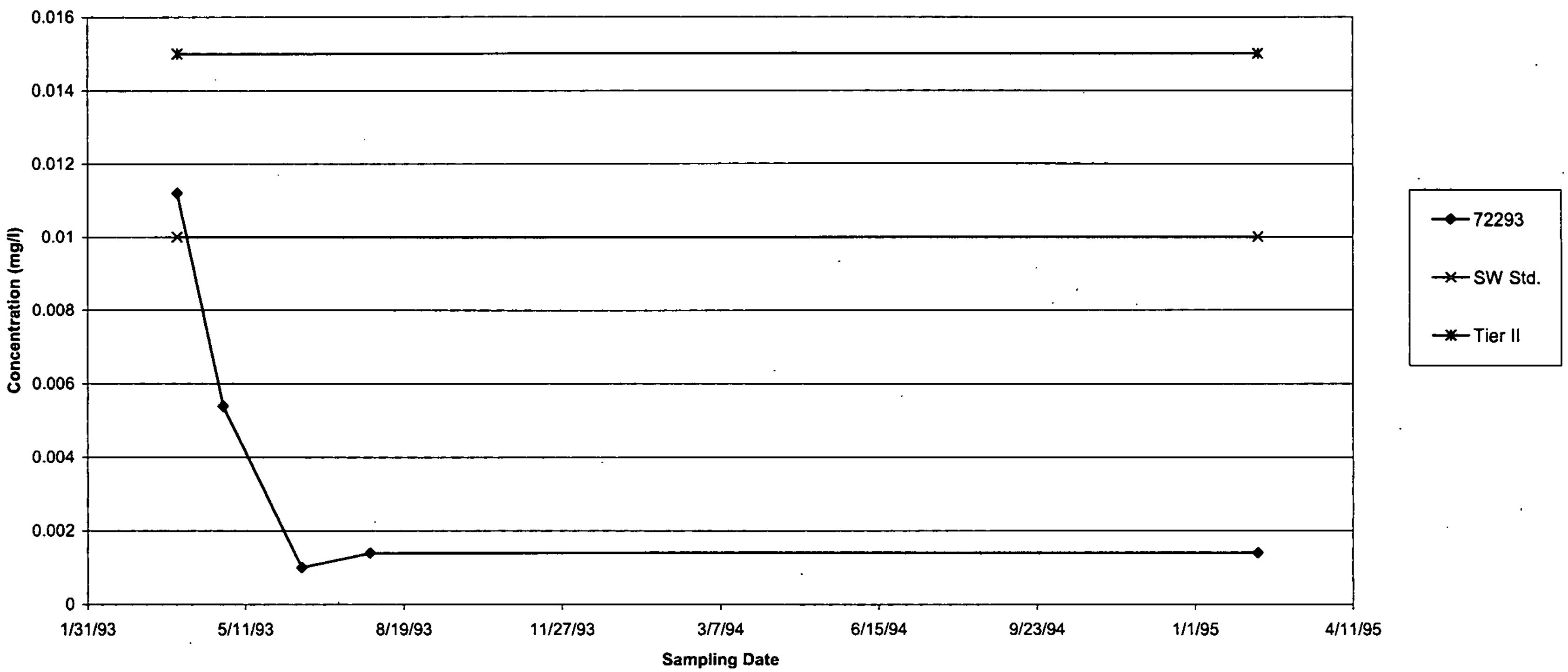


Figure C-9
Sulfide Concentrations in Unconsolidated Material Groundwater Near the Seep

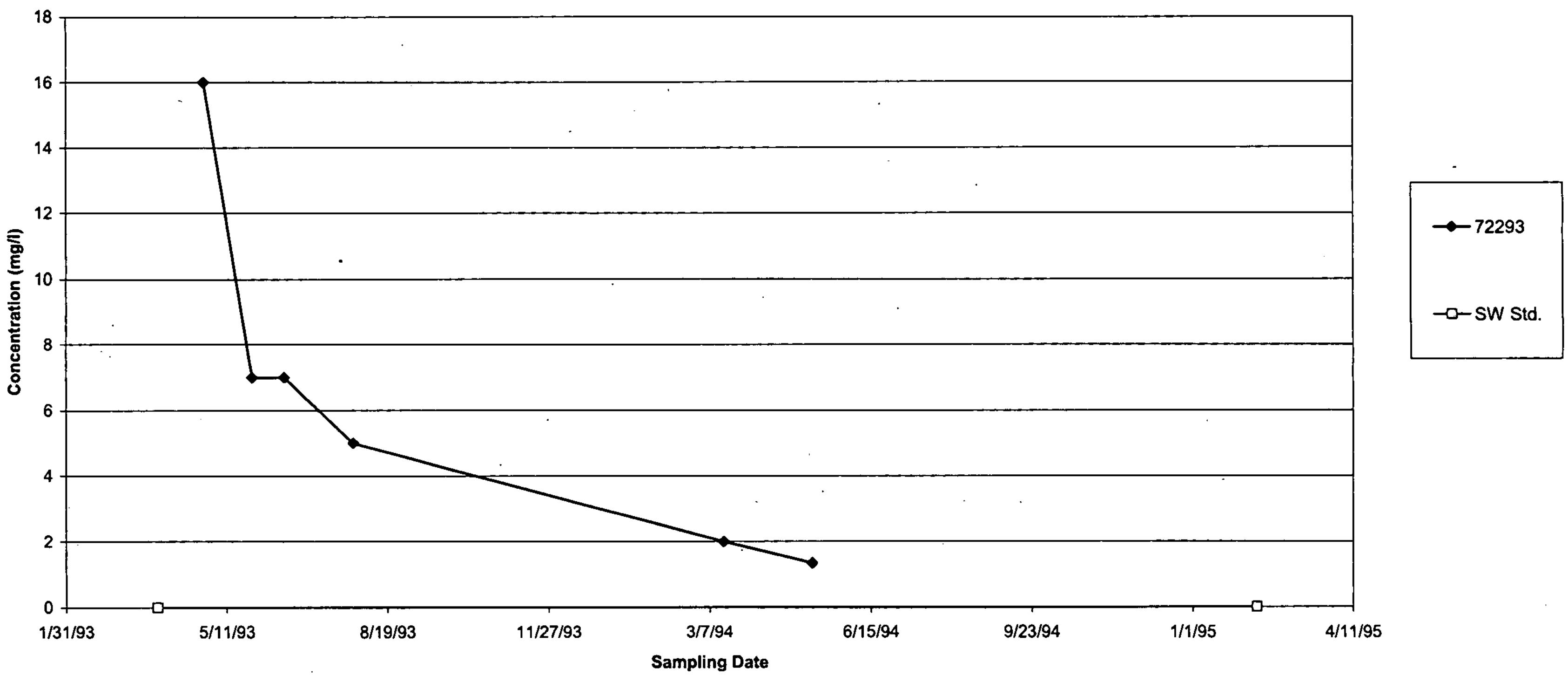


Figure C-10
Gross Alpha in Unconsolidated Material Groundwater Near the Seep

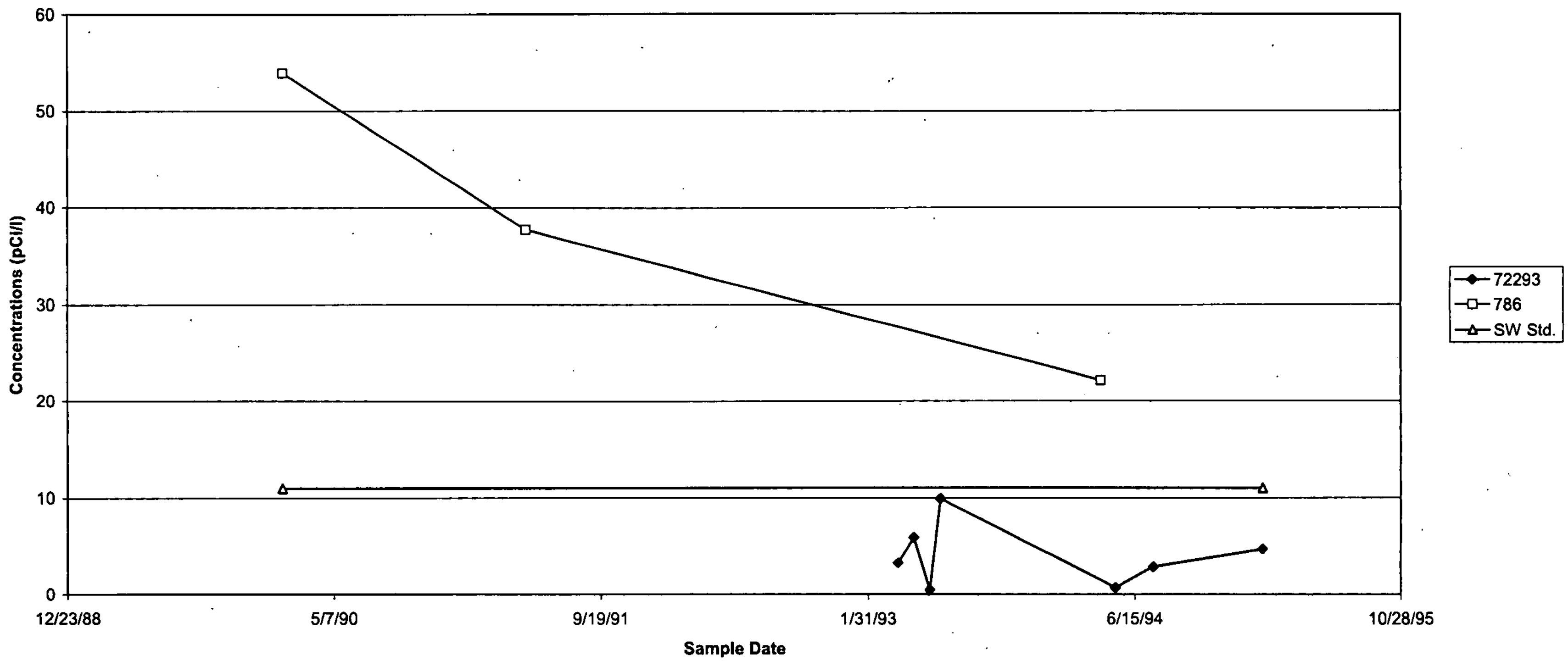


Figure C-11
Gross Beta in Unconsolidated Material Groundwater Near the Seep

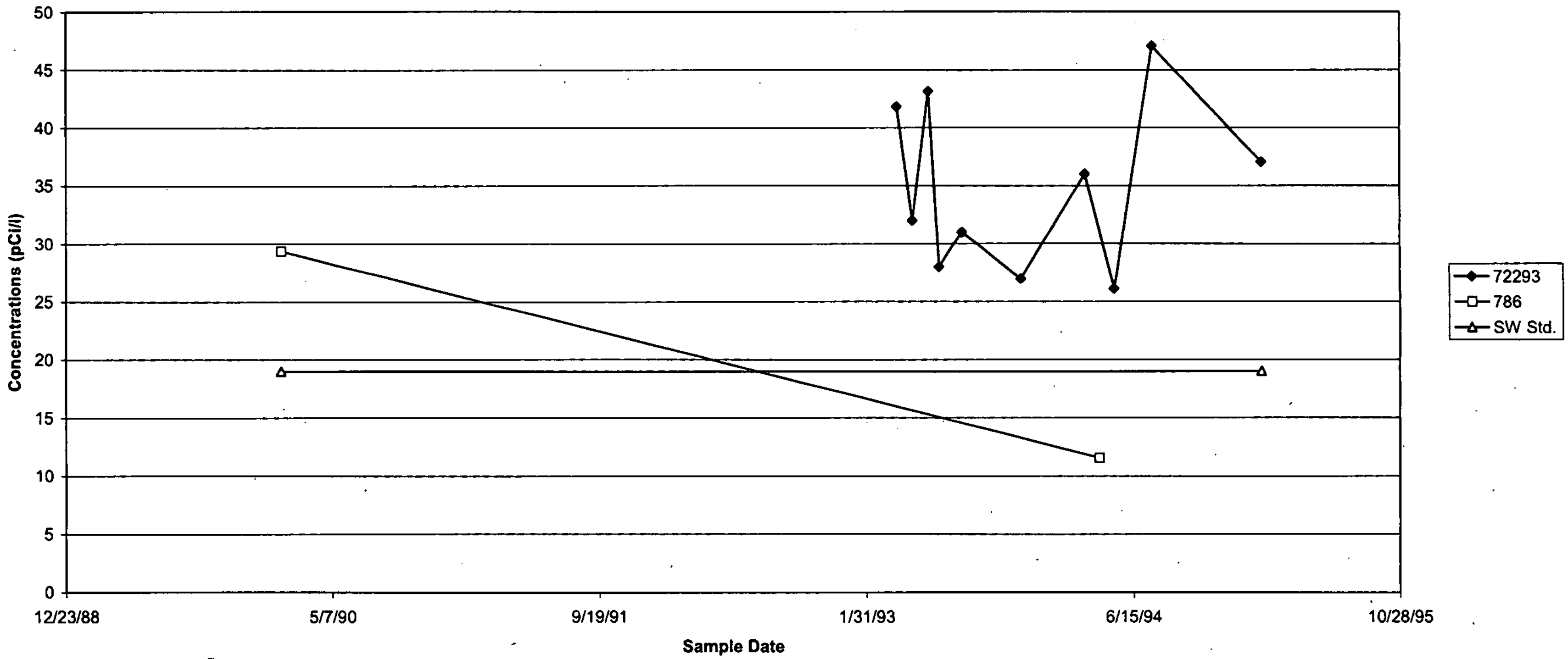


Figure C-12
Tritium in Unconsolidated Material Groundwater Near the Seep

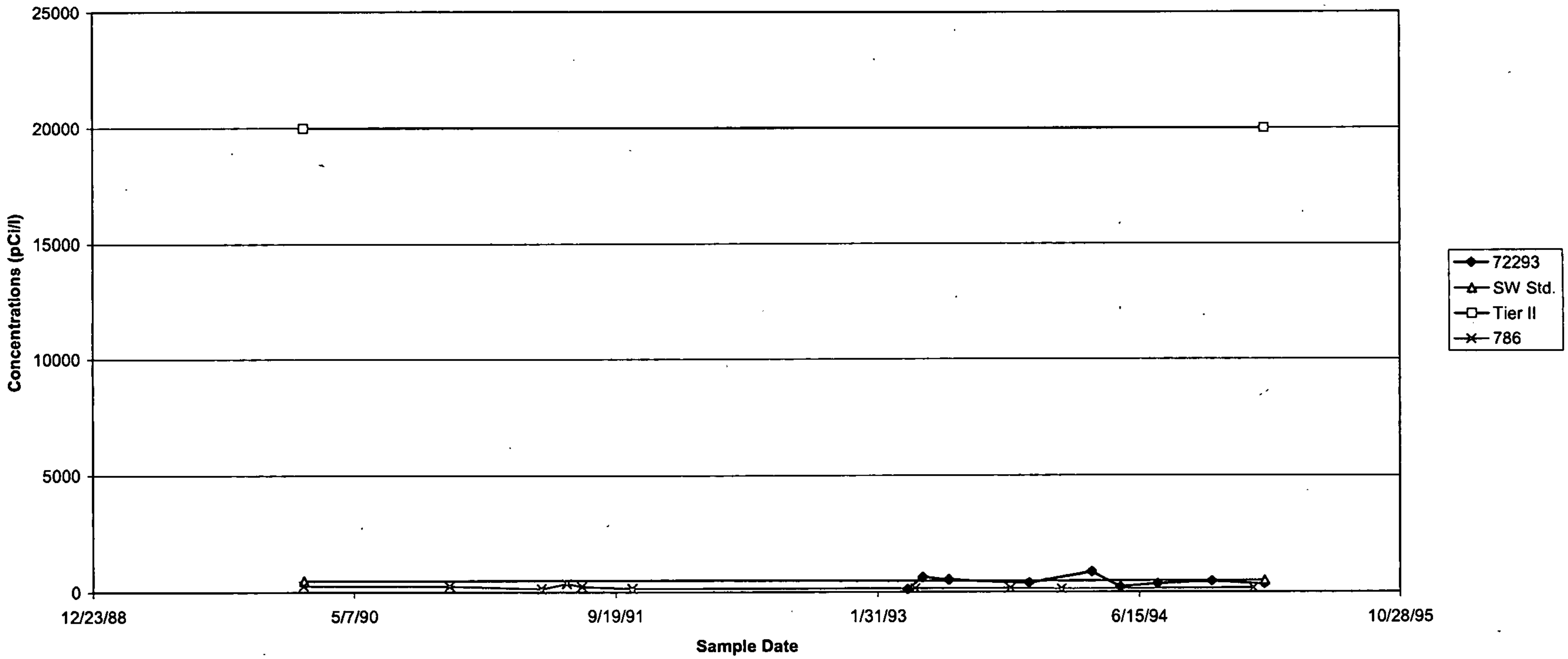


Figure C-13
Uranium 233/234 in Unconsolidated Material Groundwater Near the Seep

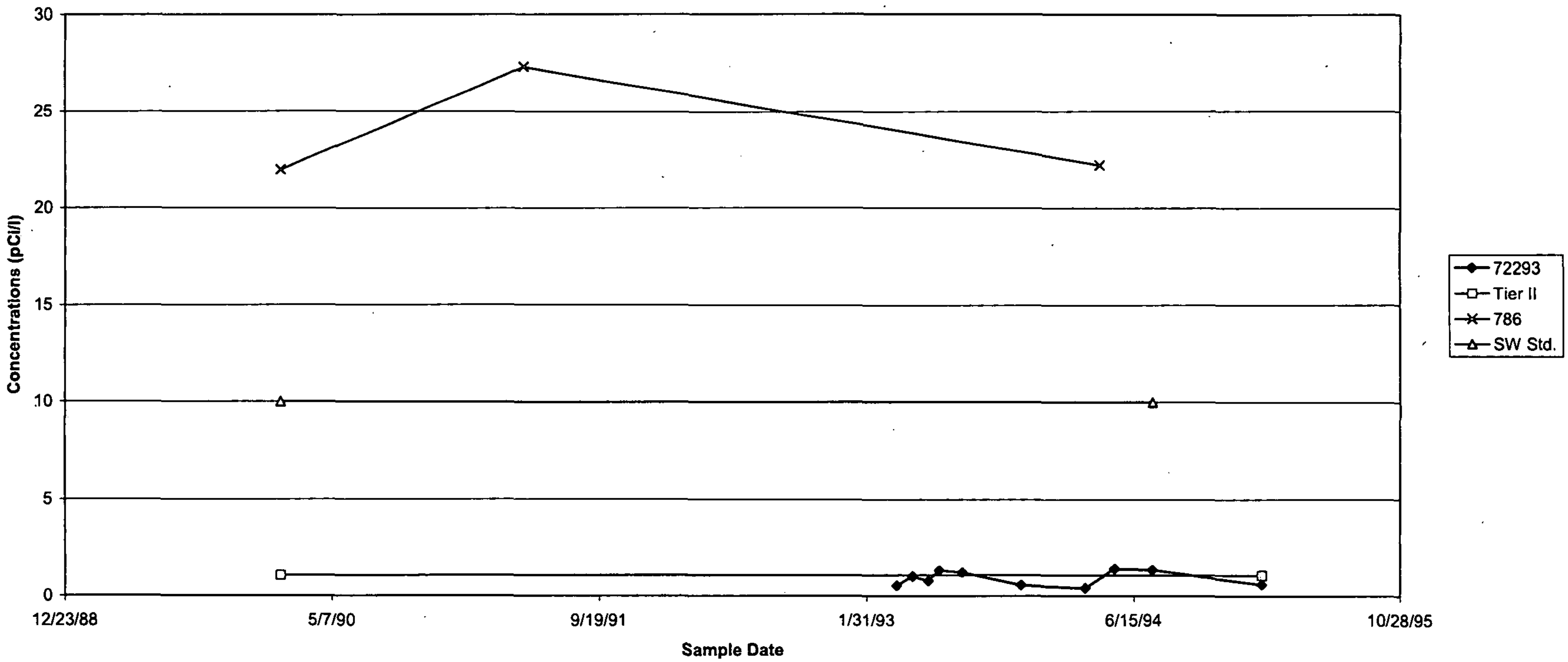
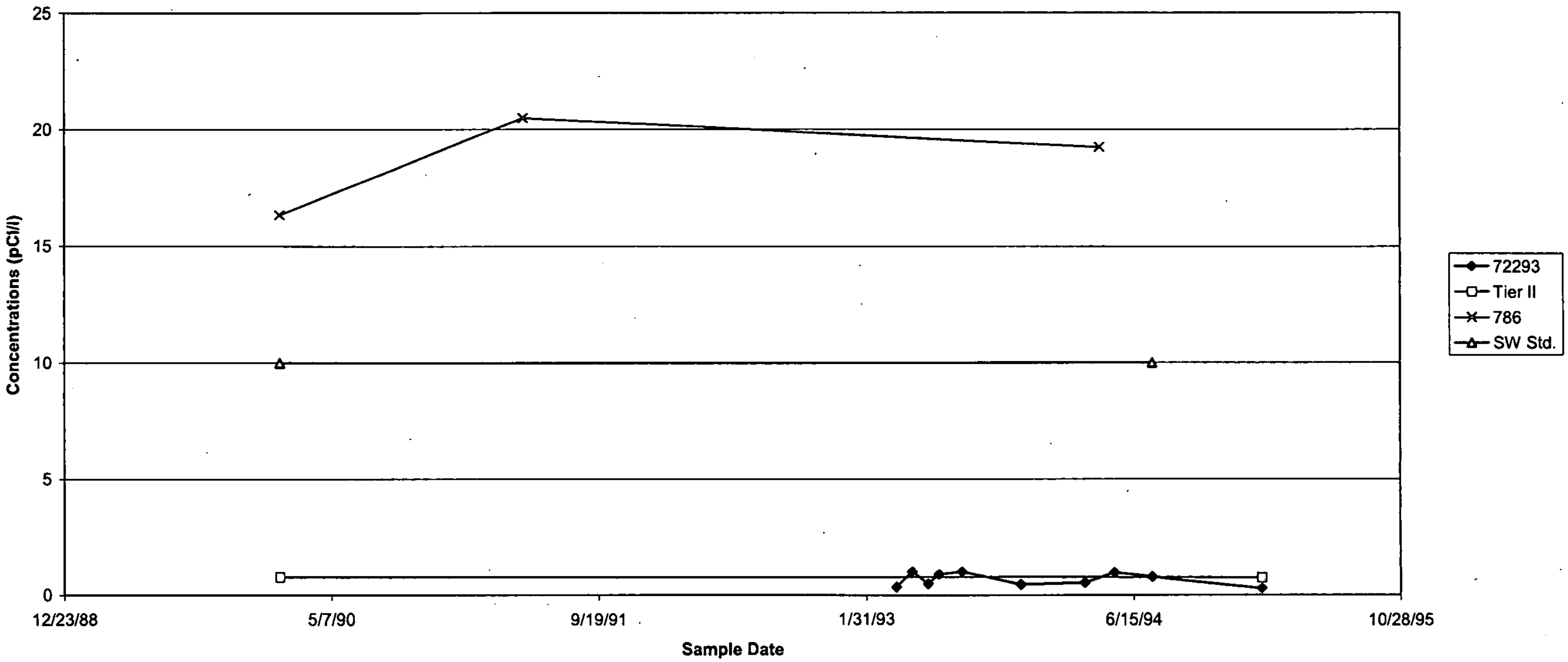


Figure C-14
Uranium 238 in Unconsolidated Material Groundwater Near the Seep



APPENDIX D
SURFACE WATER QUALITY TIME SERIES PLOTS

Figure D-1
Benzene in Surface Water

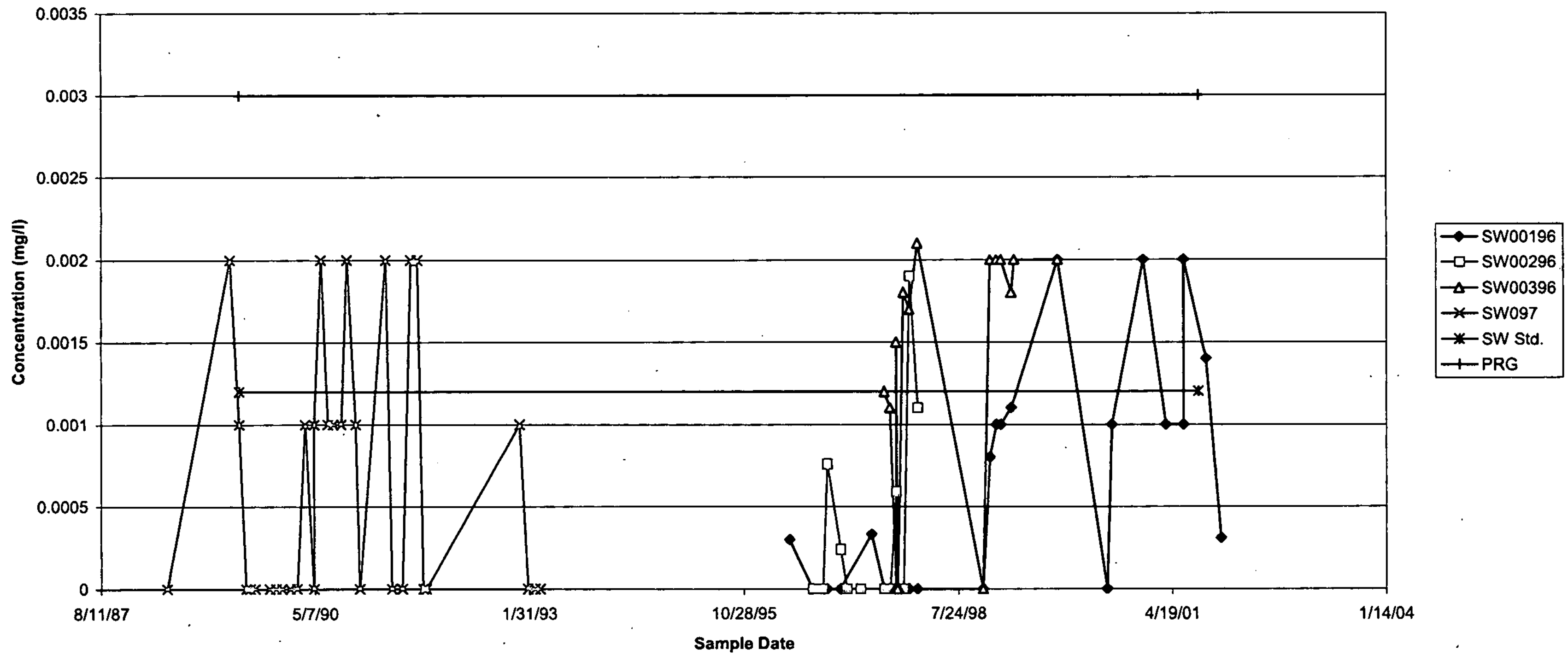


Figure D-2
Bis(2-ethyhexyl)phthalate in Surface Water

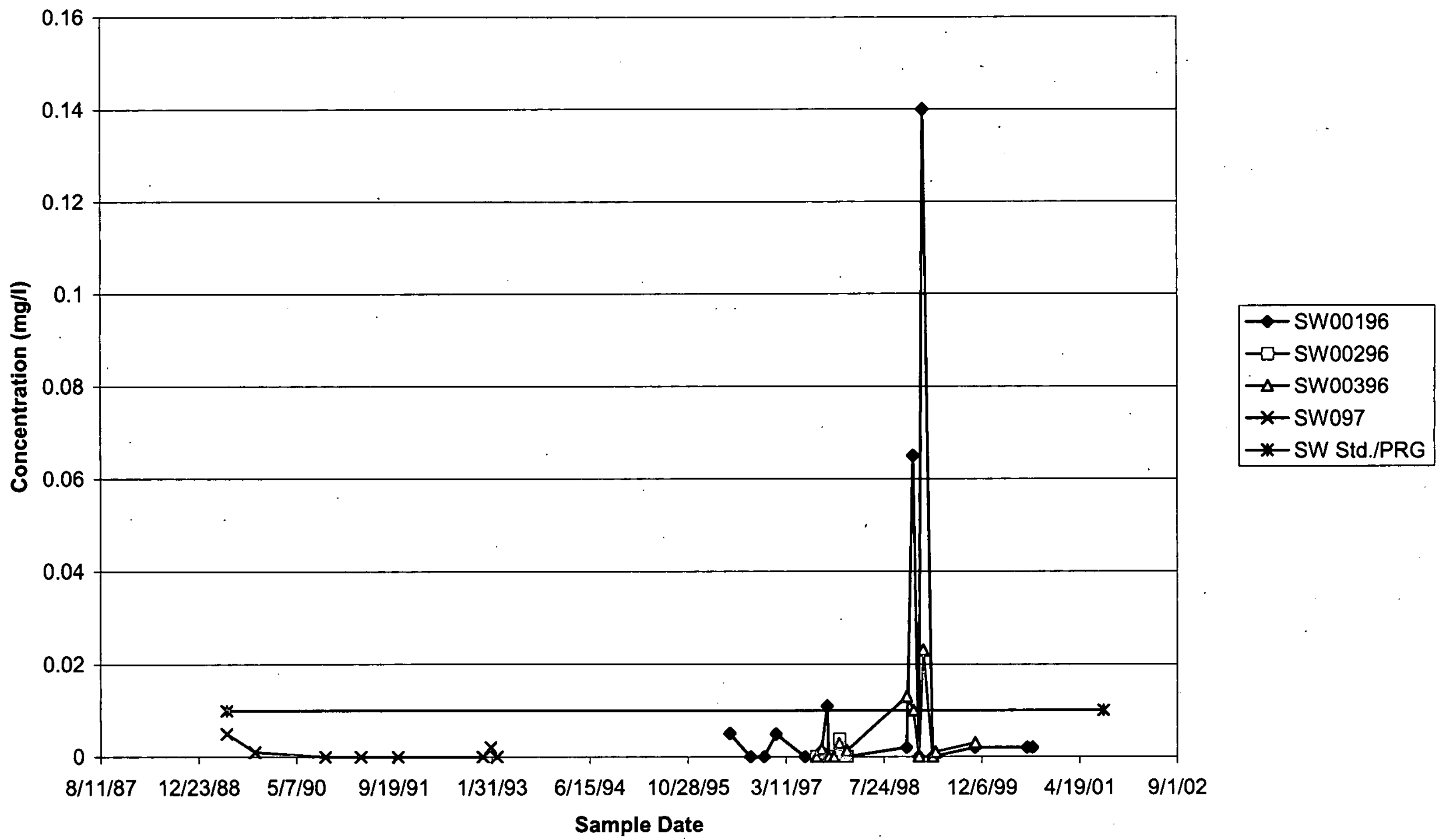


Figure D-3
Chloroethane in Surface Water

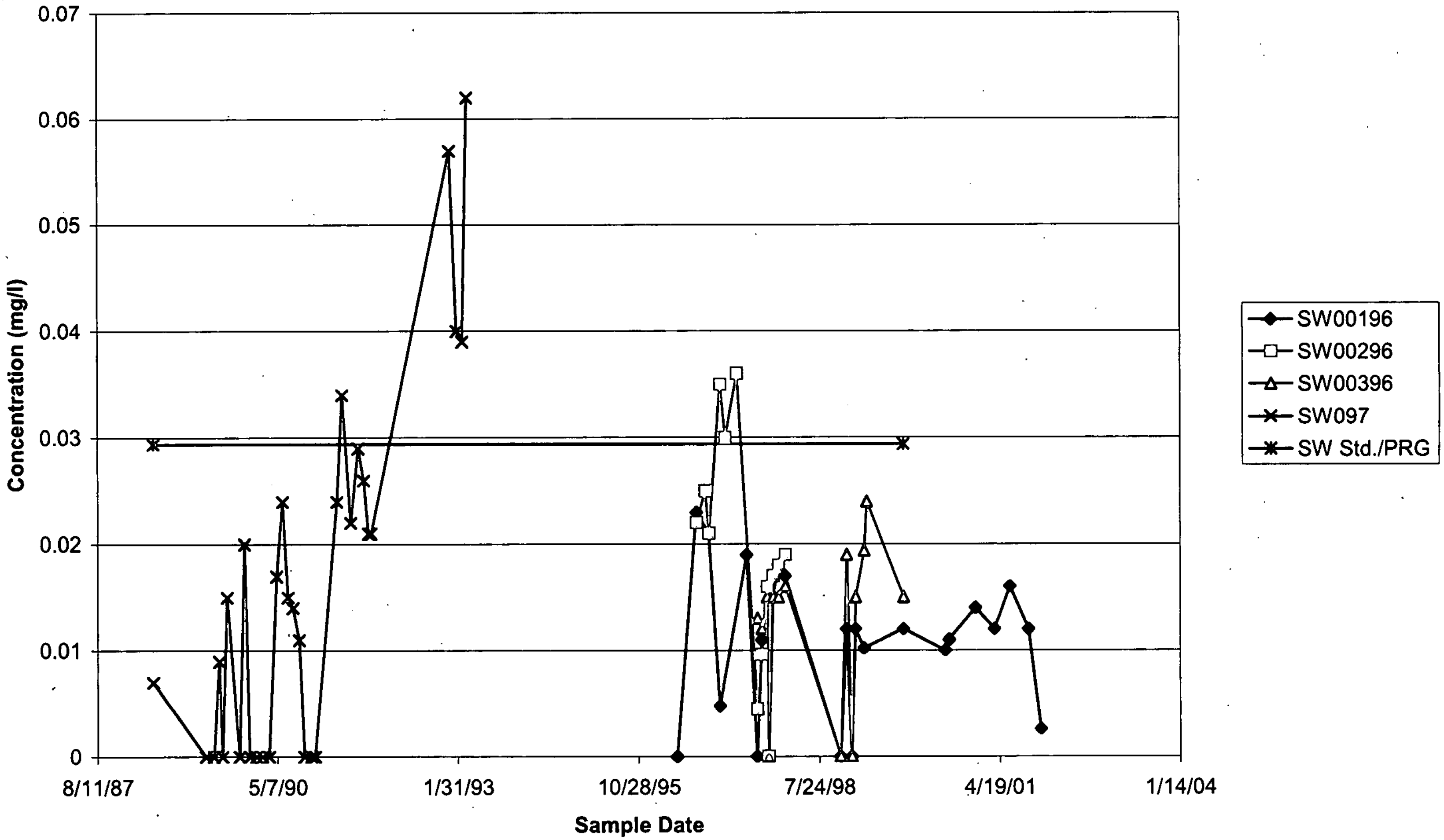


Figure D-4
Methylene Chloride in Surface Water

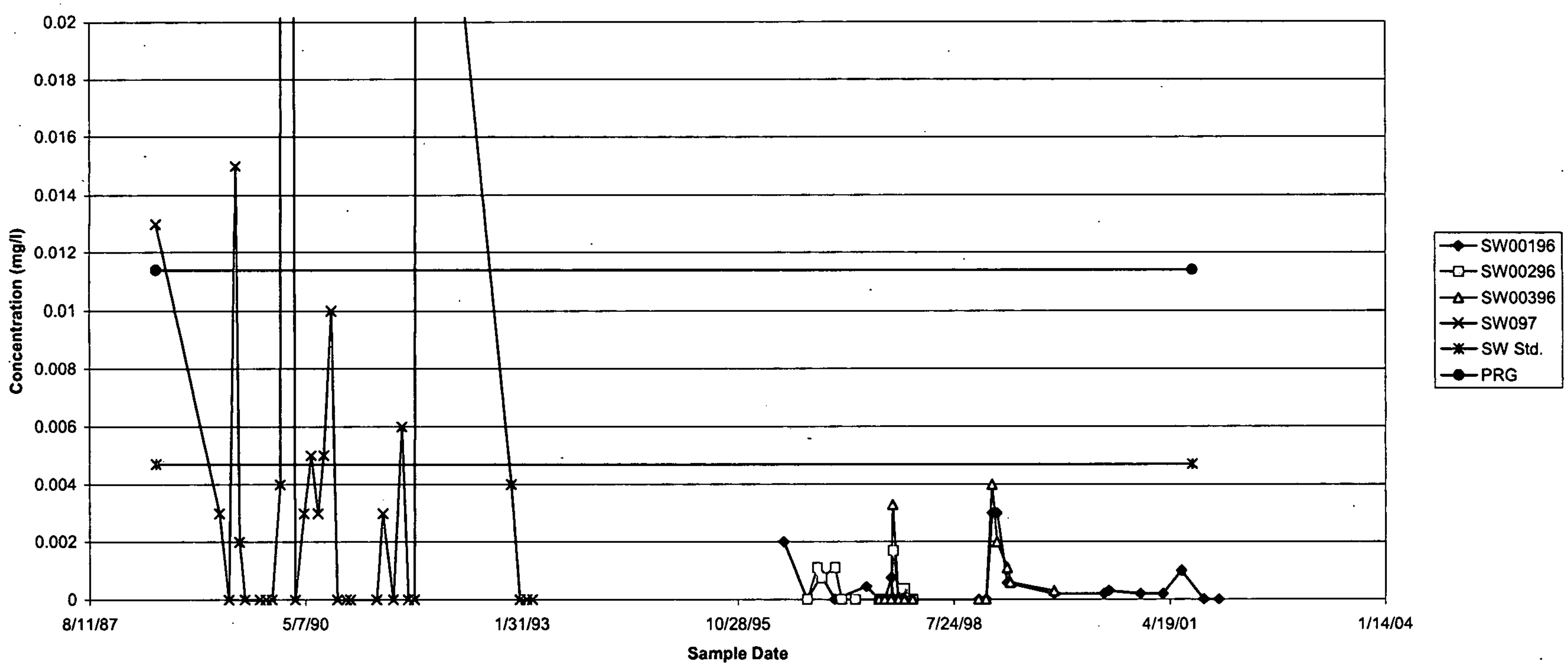


Figure D-5
Naphthalene in Surface Water

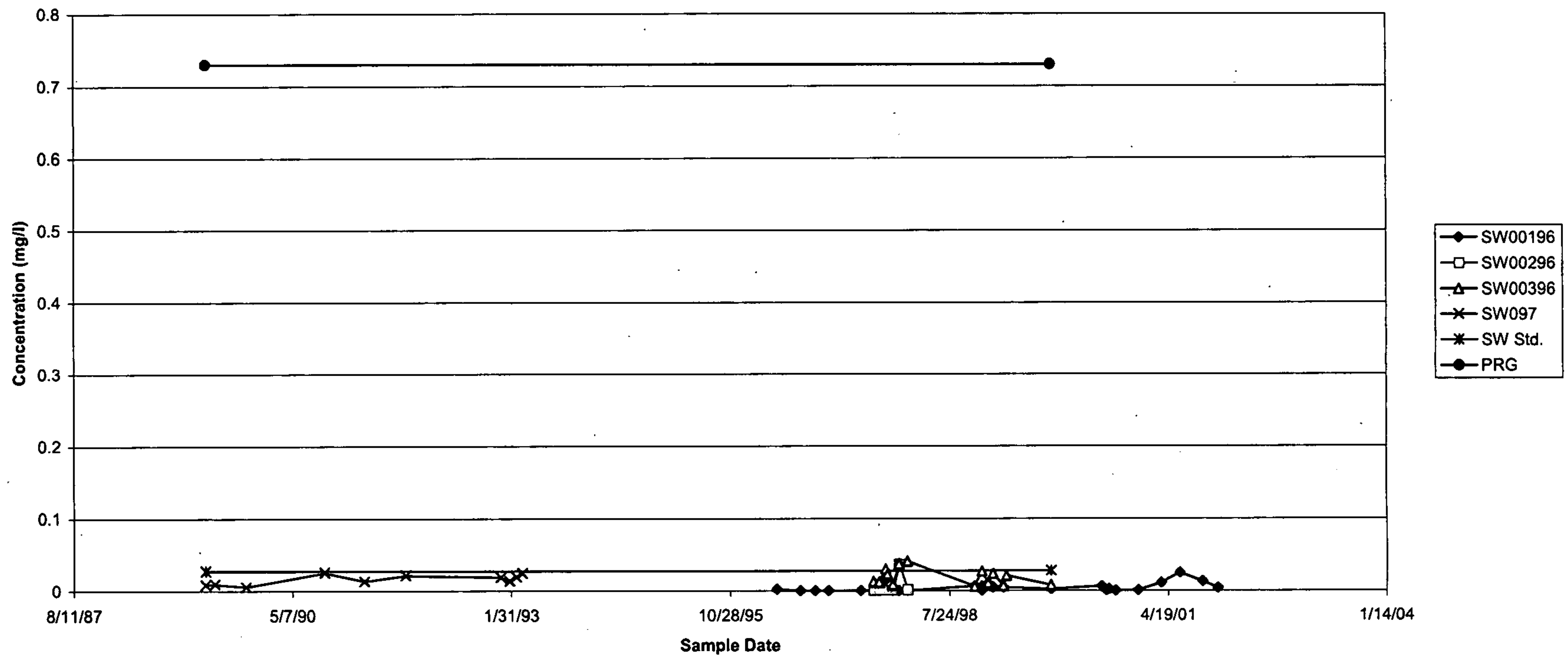


Figure D-6
Vinyl Chloride in Surface Water

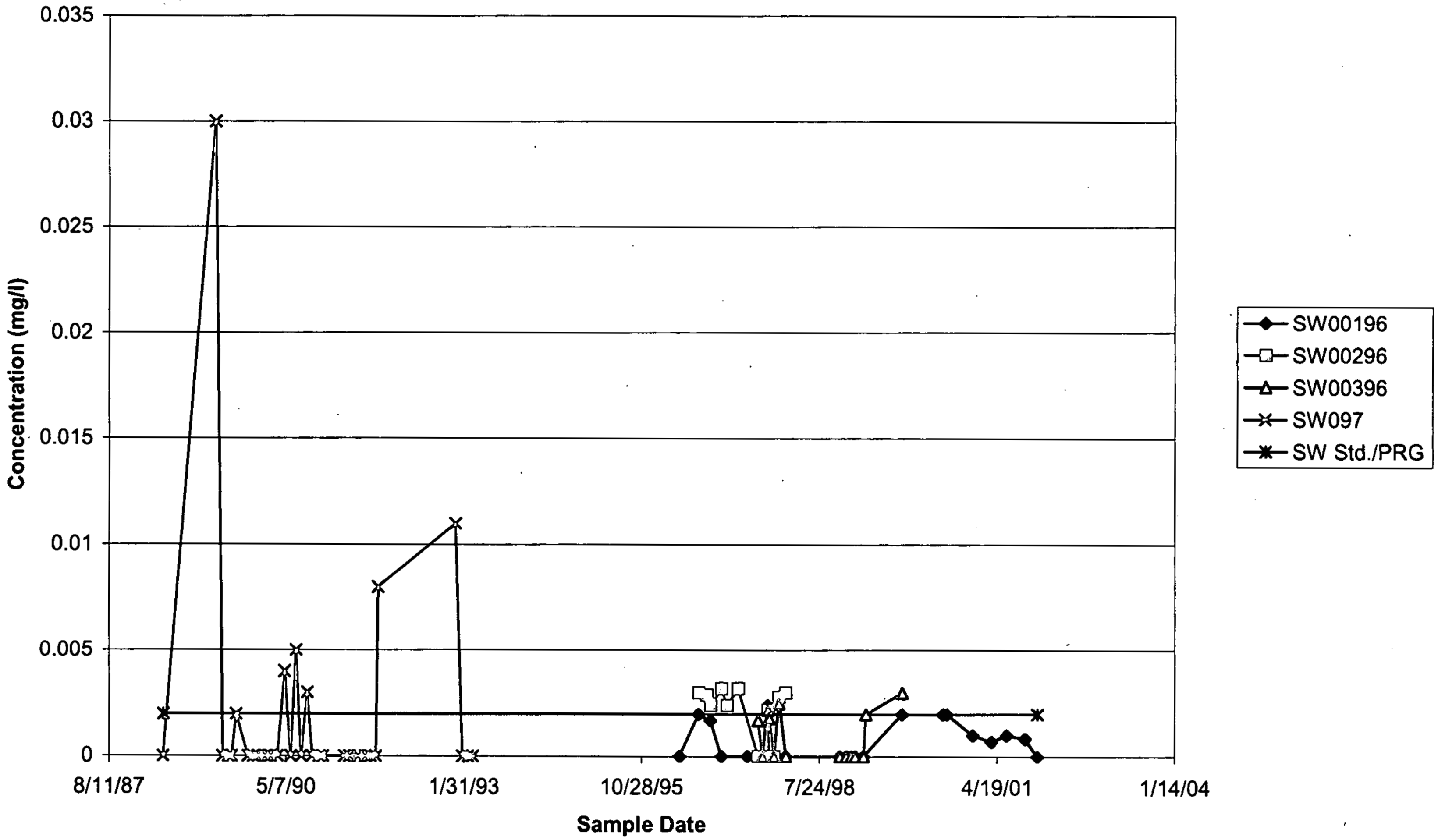


Figure D-7
Aluminum in Surface Water

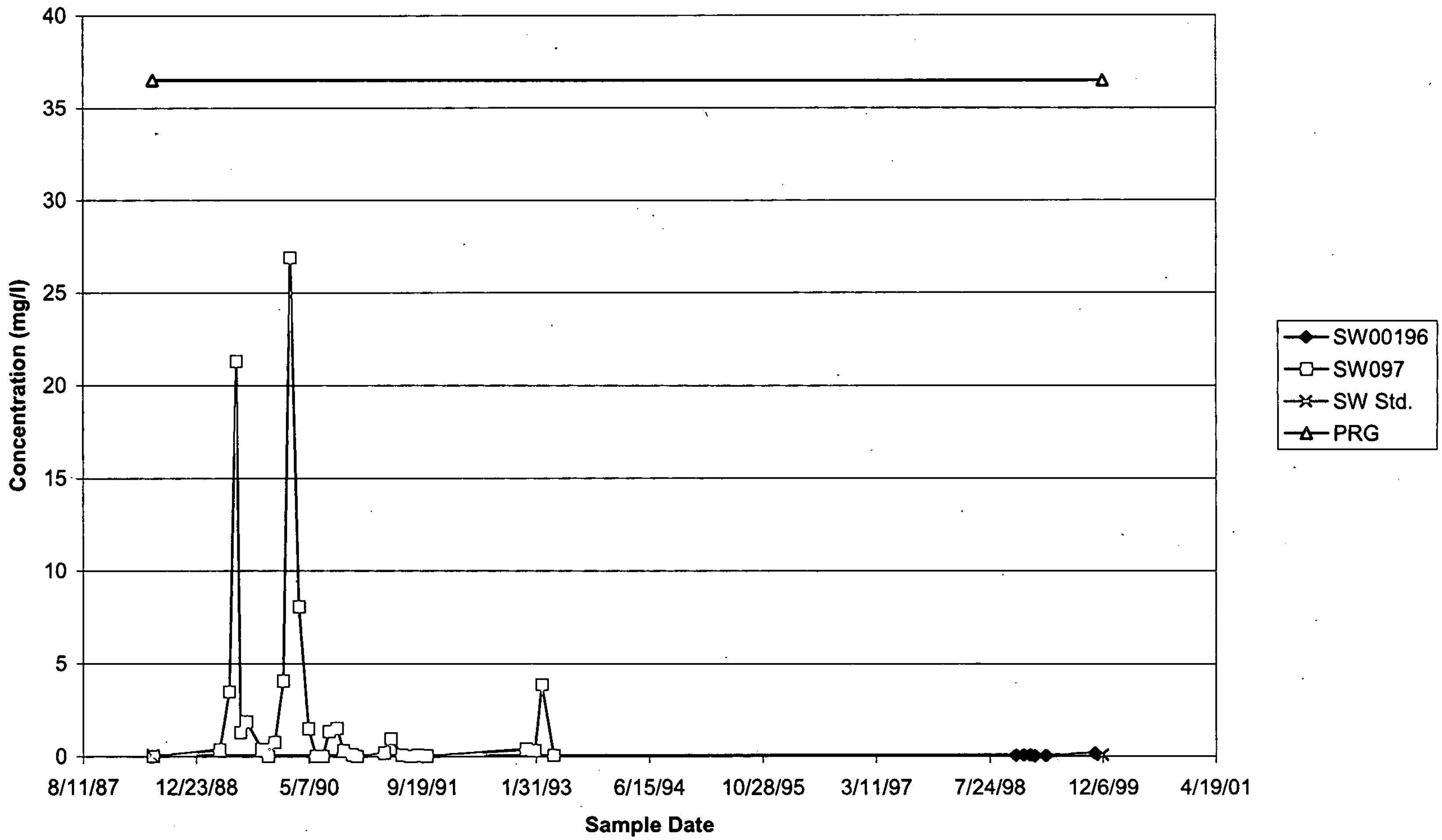


Figure D-8
Antimony in Surface Water

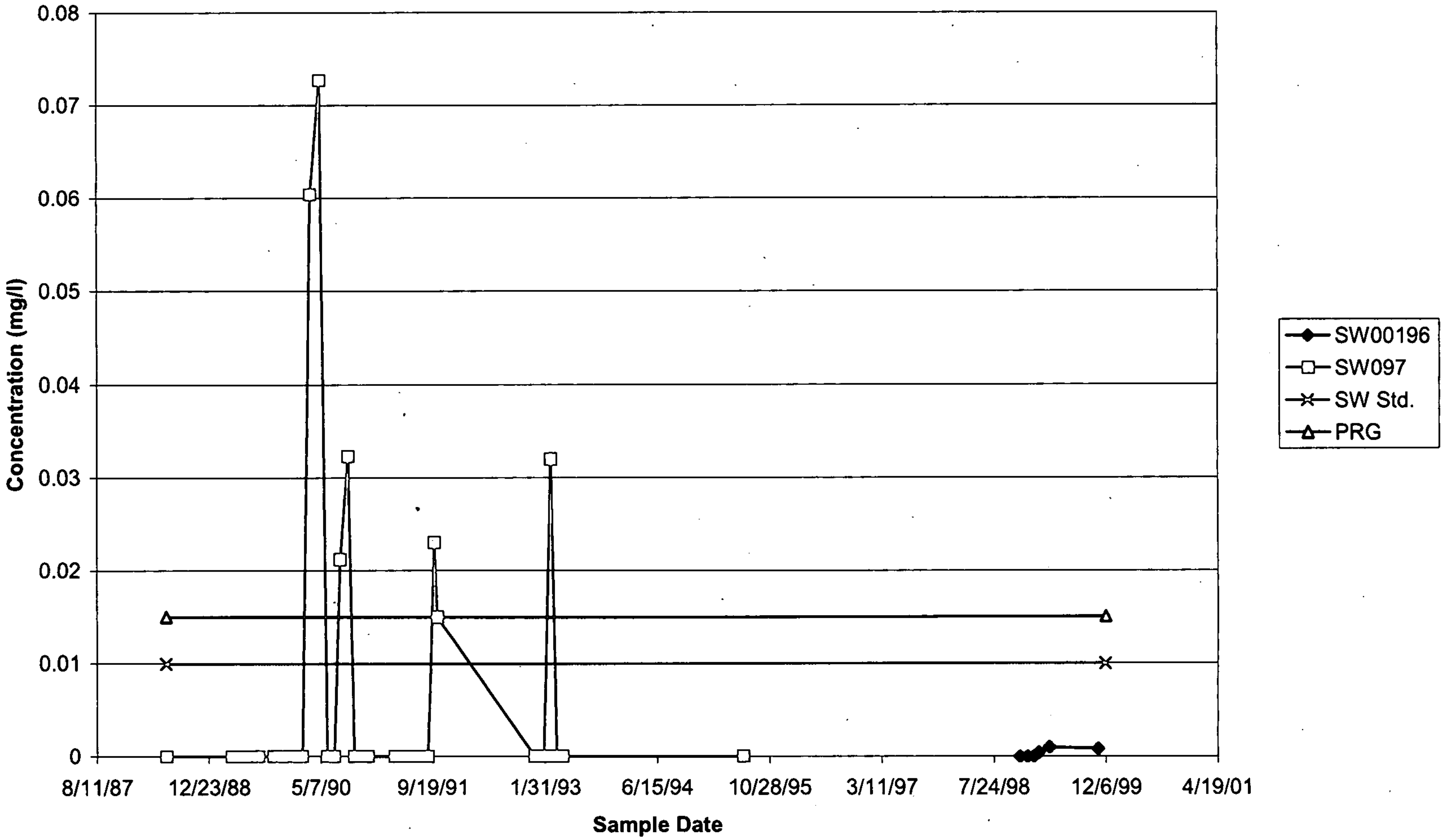


Figure D-9
Barium in Surface Water

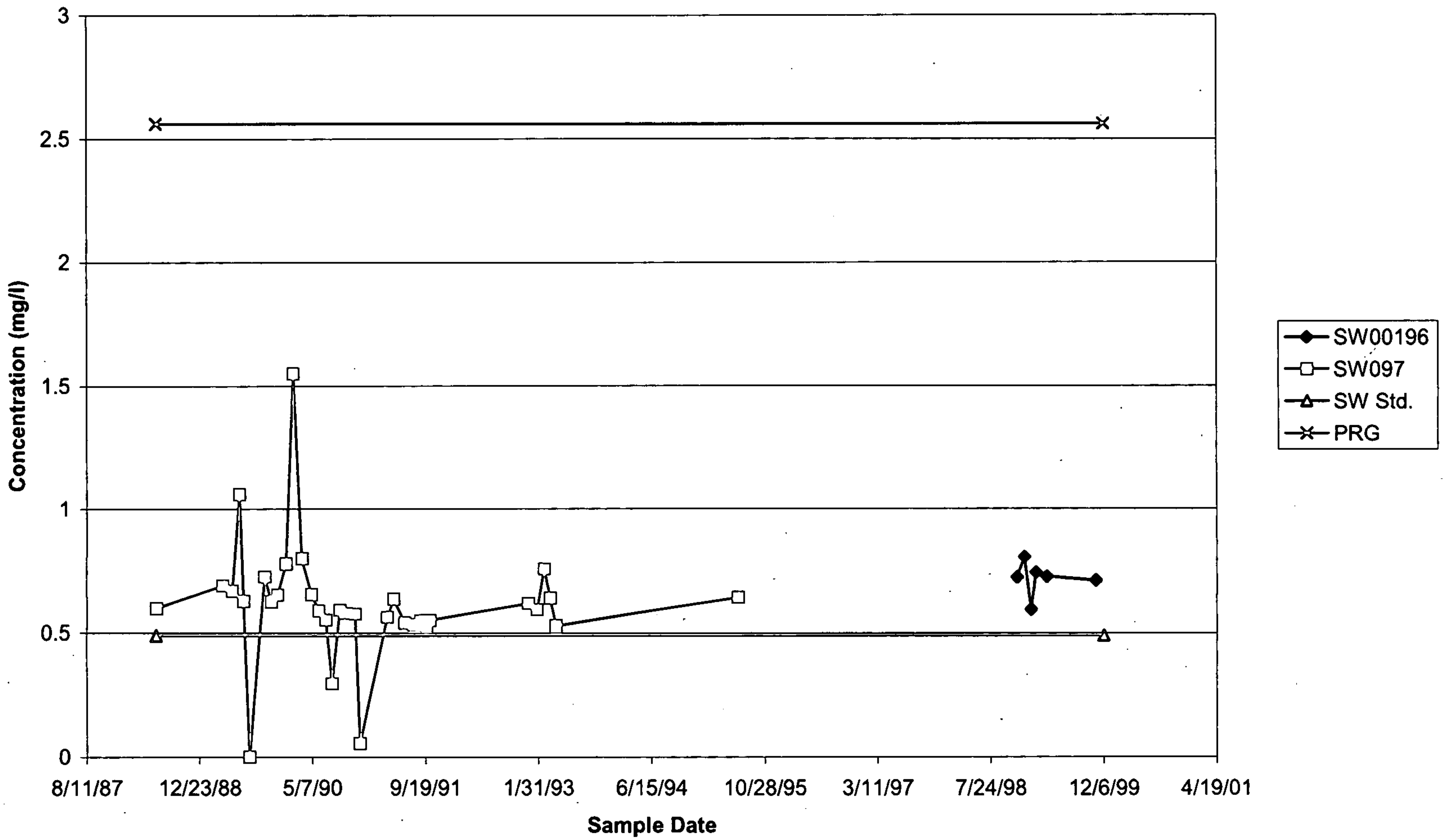


Figure D-10
Beryllium in Surface Water

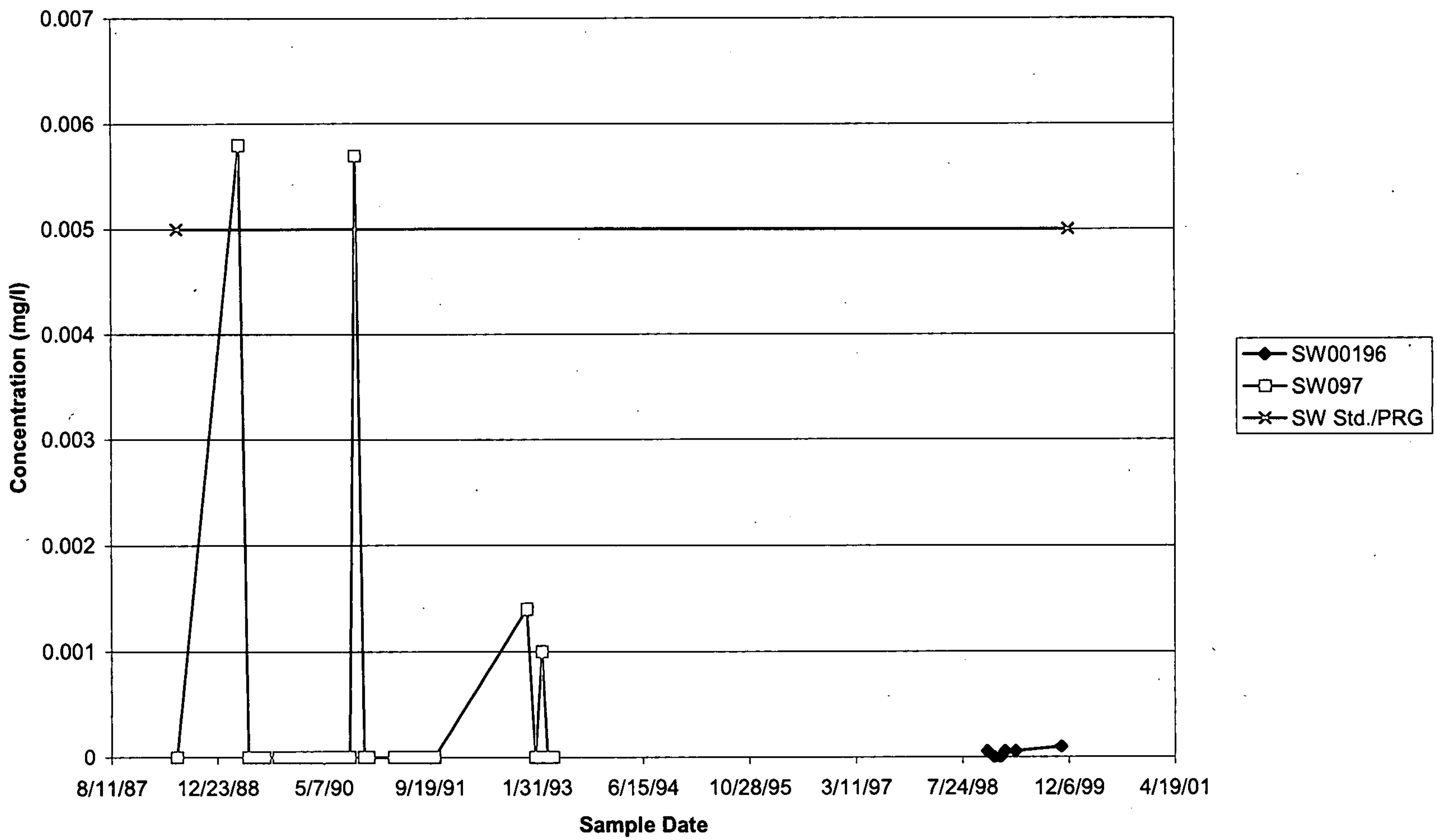


Figure D-11
Cadmium in Surface Water

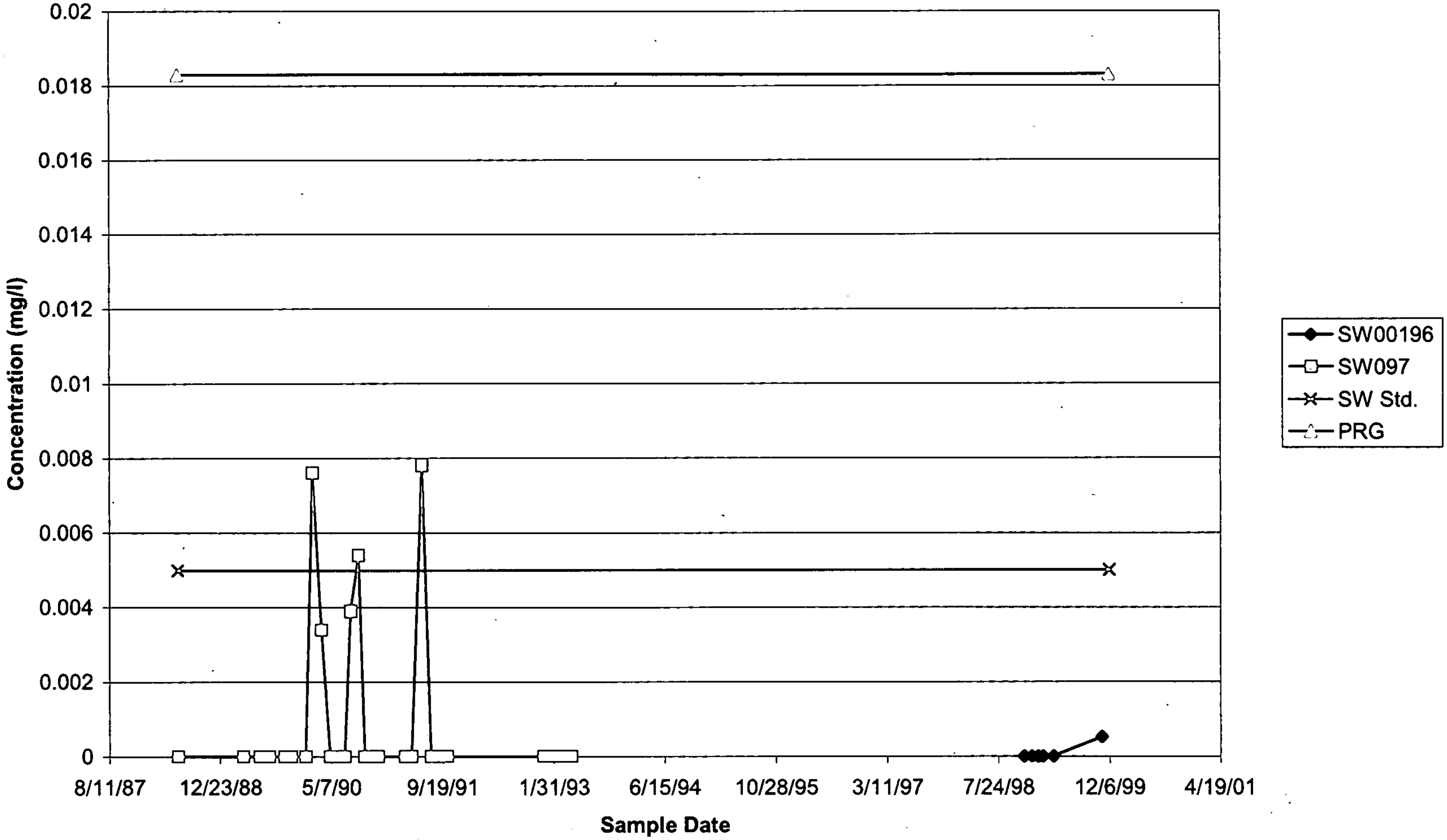


Figure D-12
Copper in Surface Water

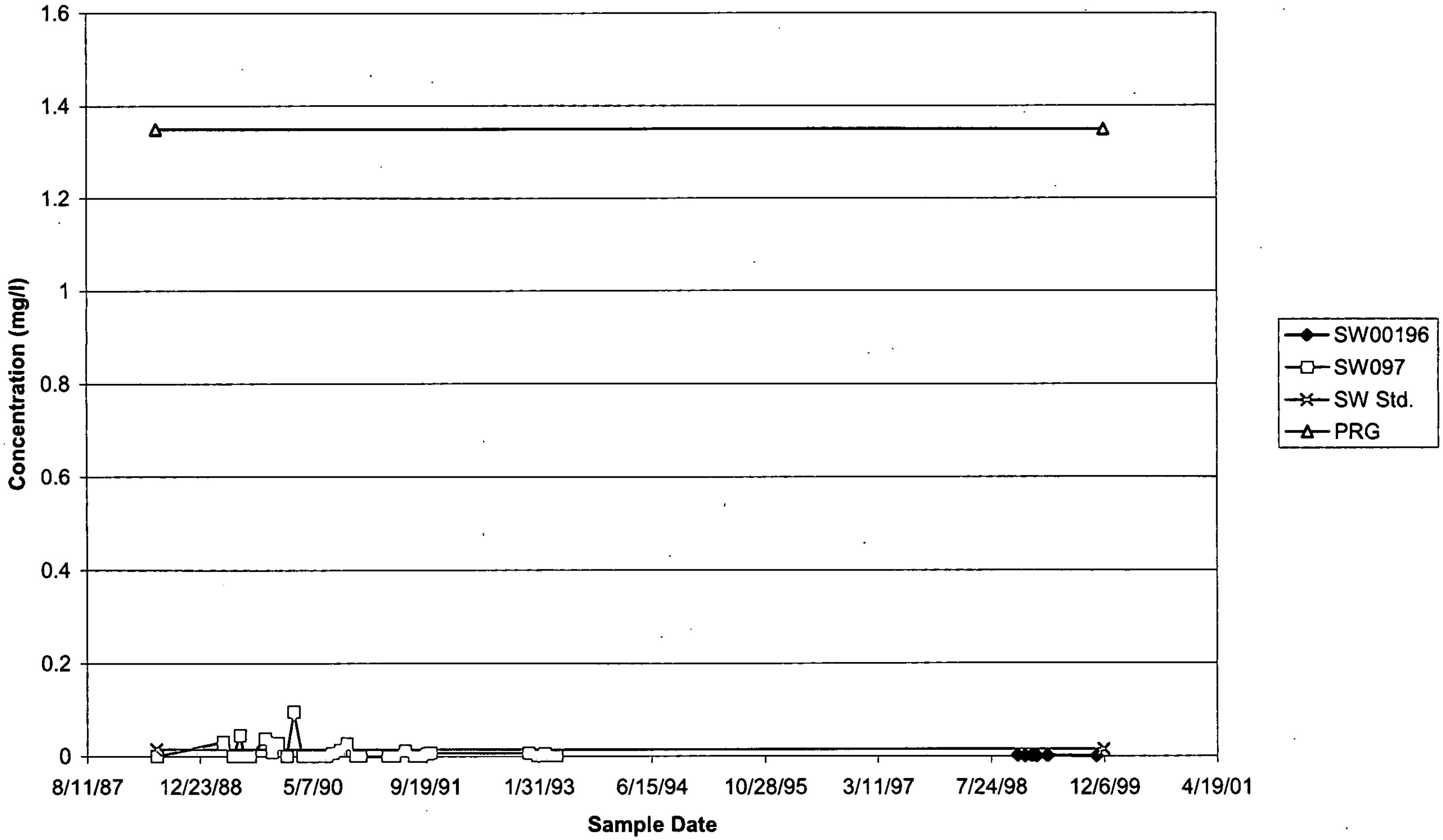


Figure D-13
Lead in Surface Water

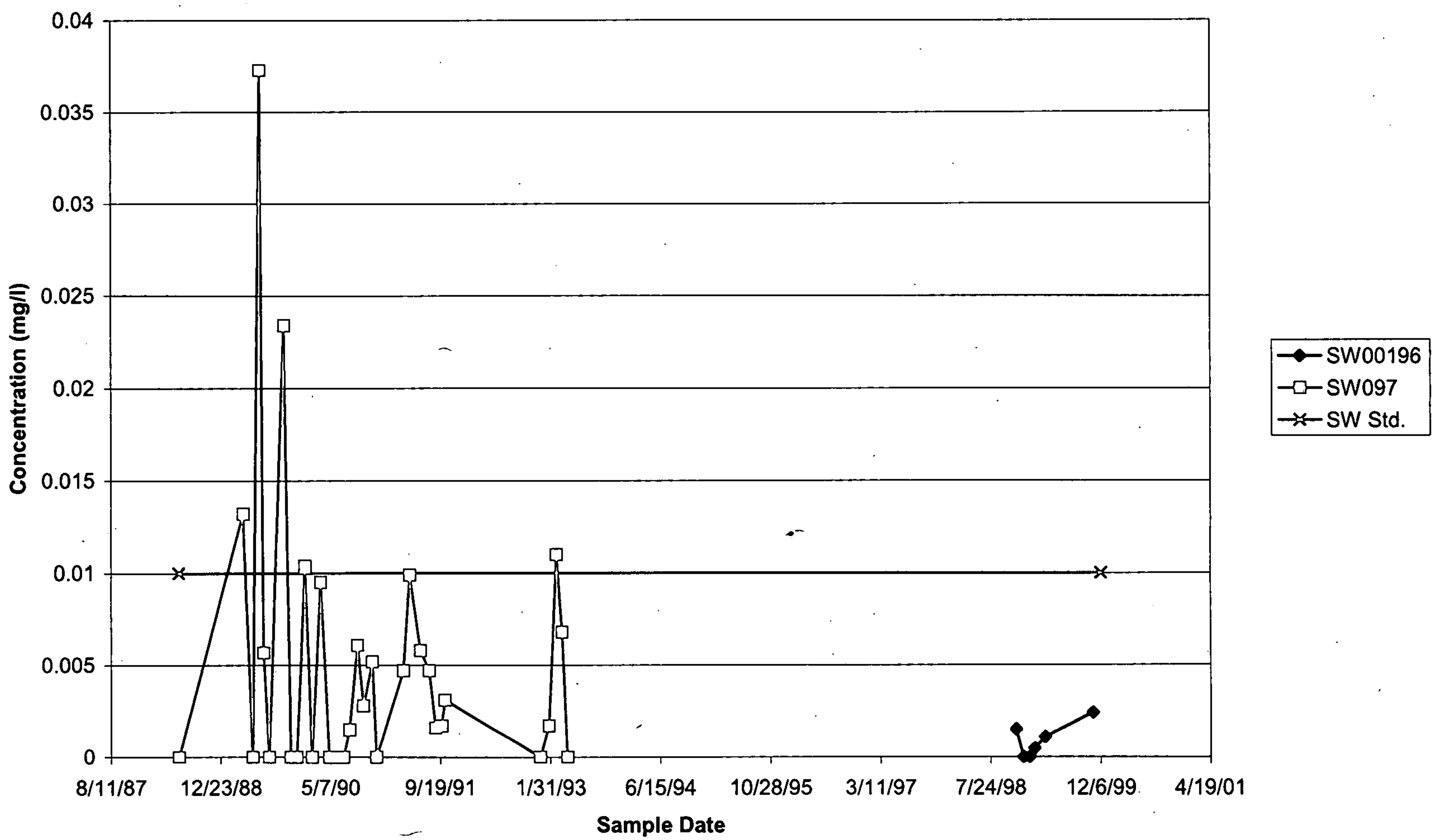


Figure D-14
Mercury in Surface Water

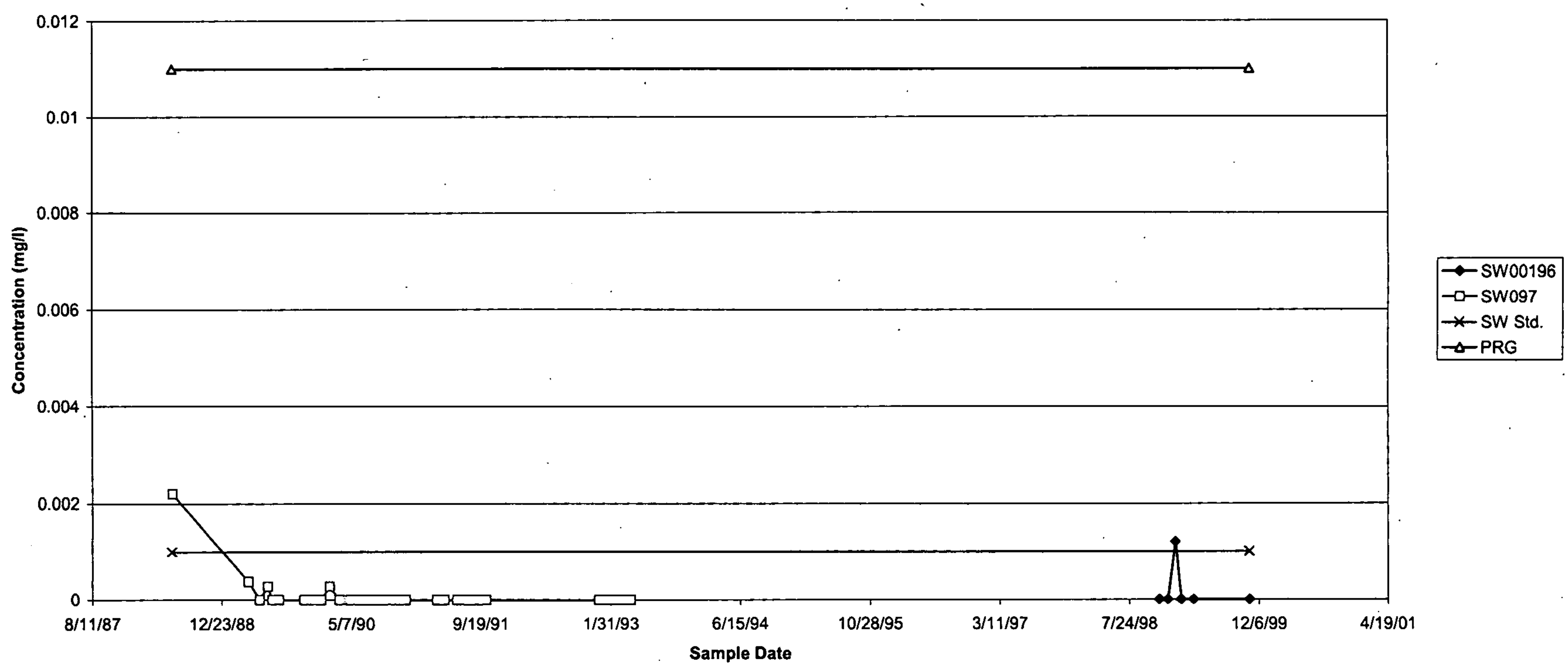


Figure D-15
Silver in Surface Water

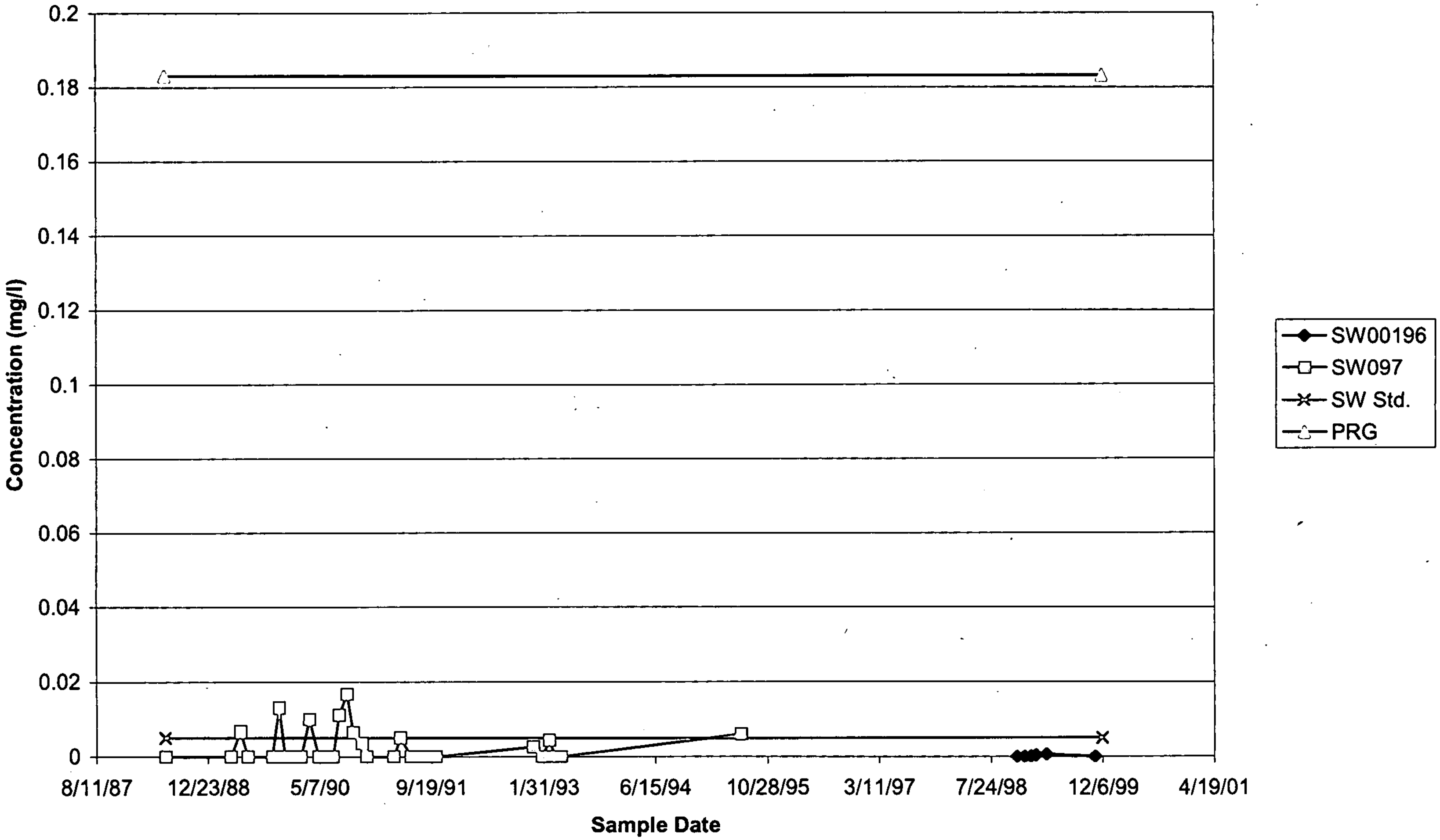


Figure D-16
Zinc in Surface Water

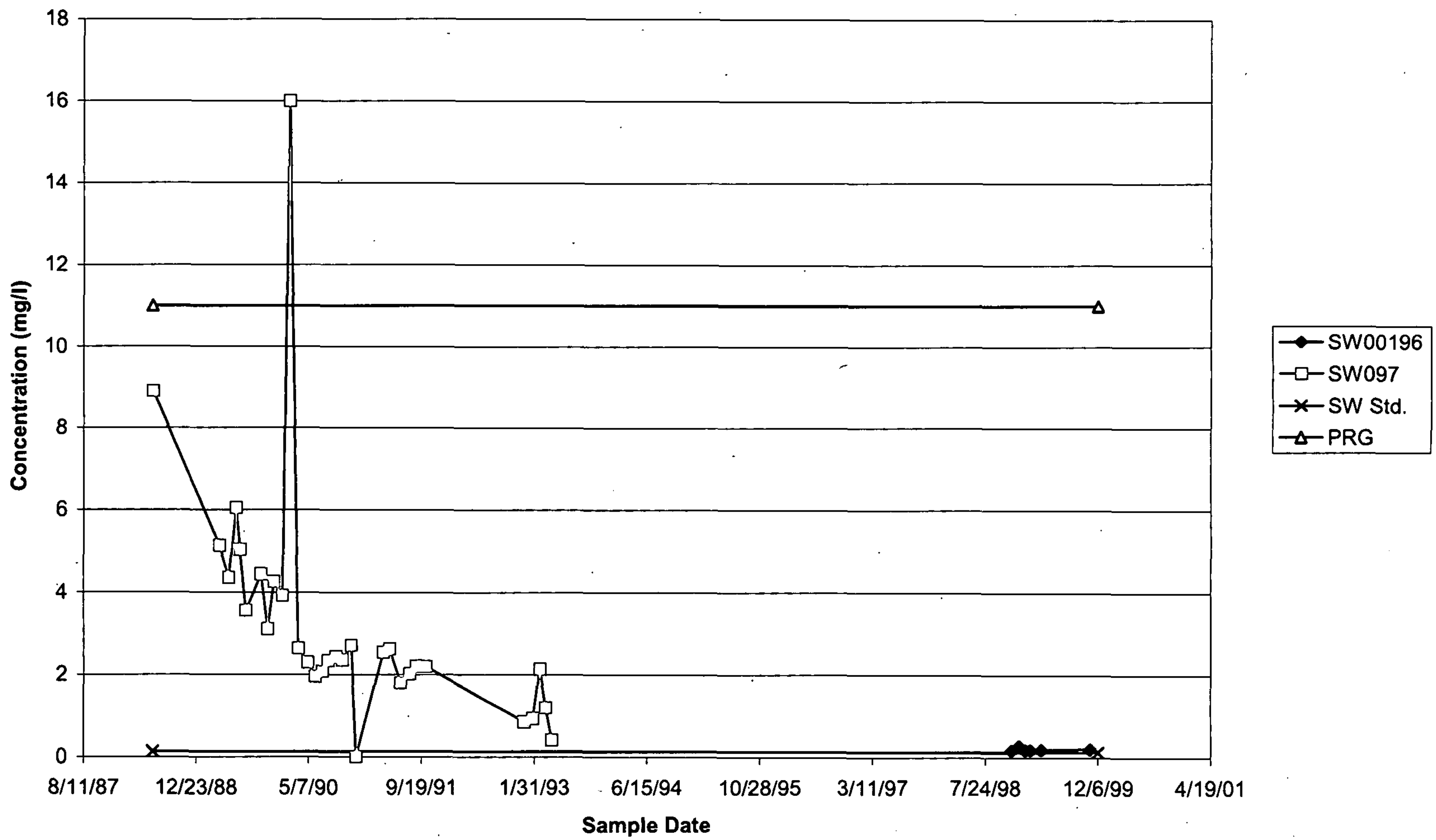


Figure D-17
Gross Alpha in Surface Water

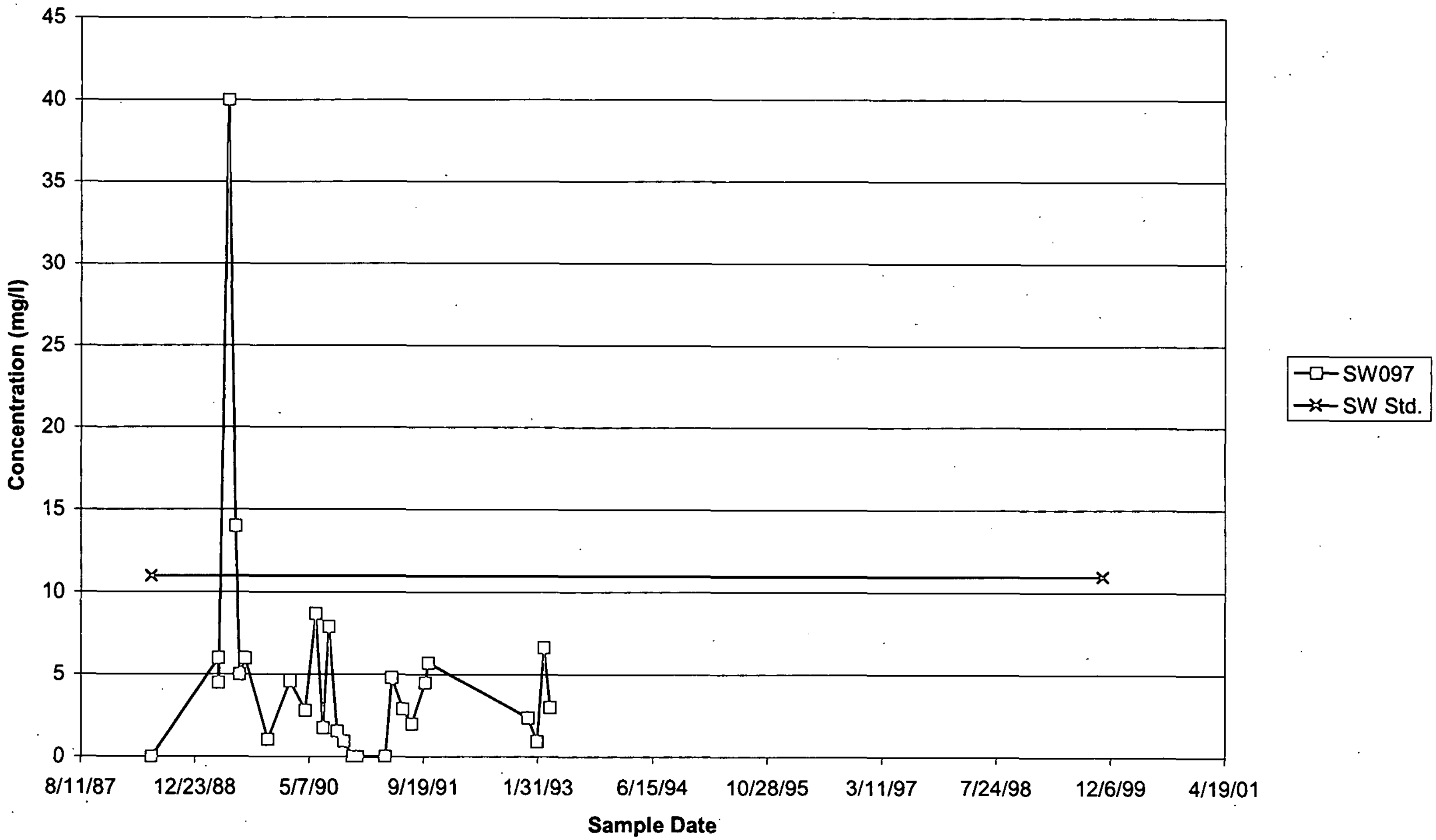


Figure D-18
Gross Beta in Surface Water

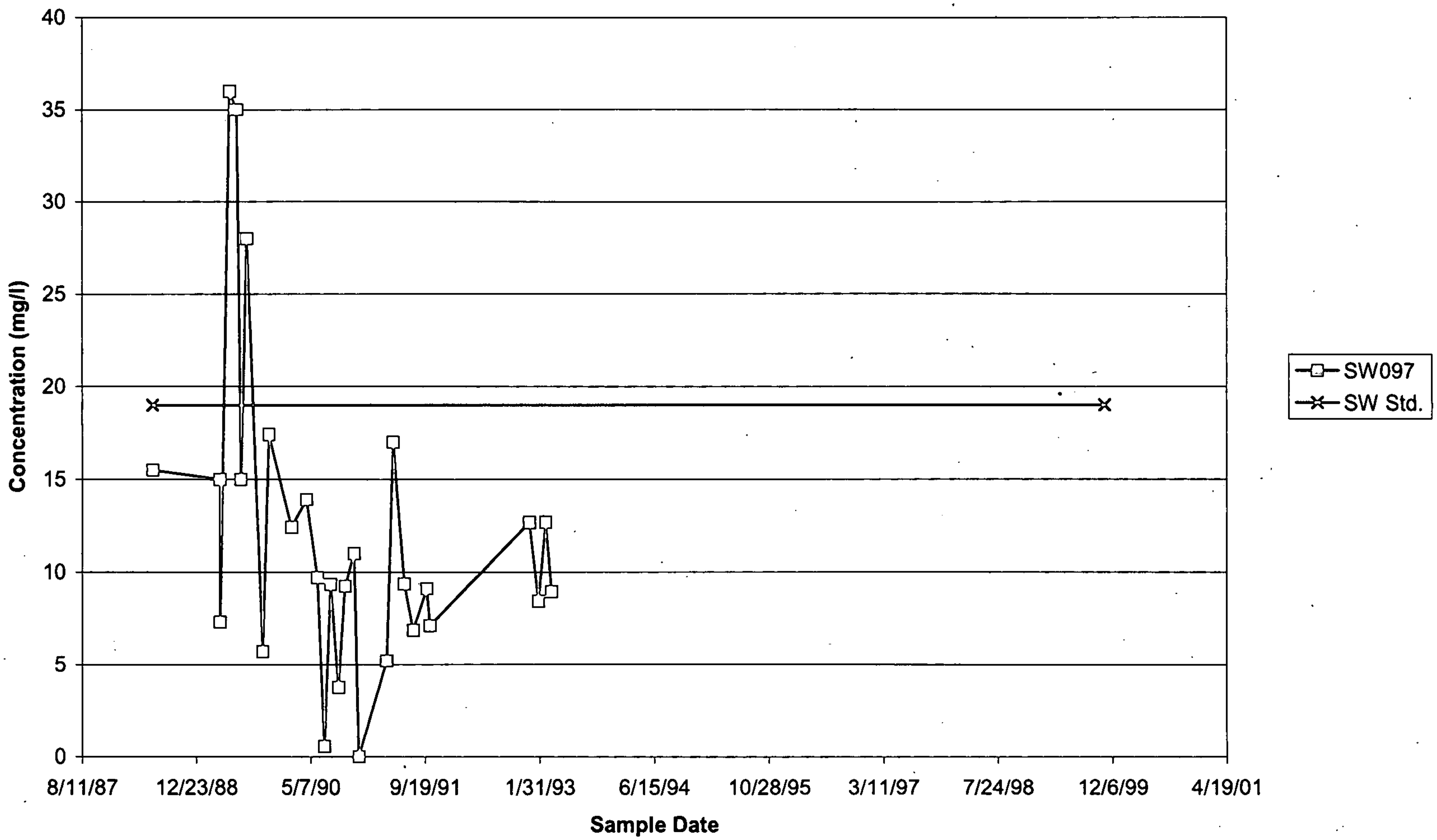


Figure D-19
Plutonium in Surface Water

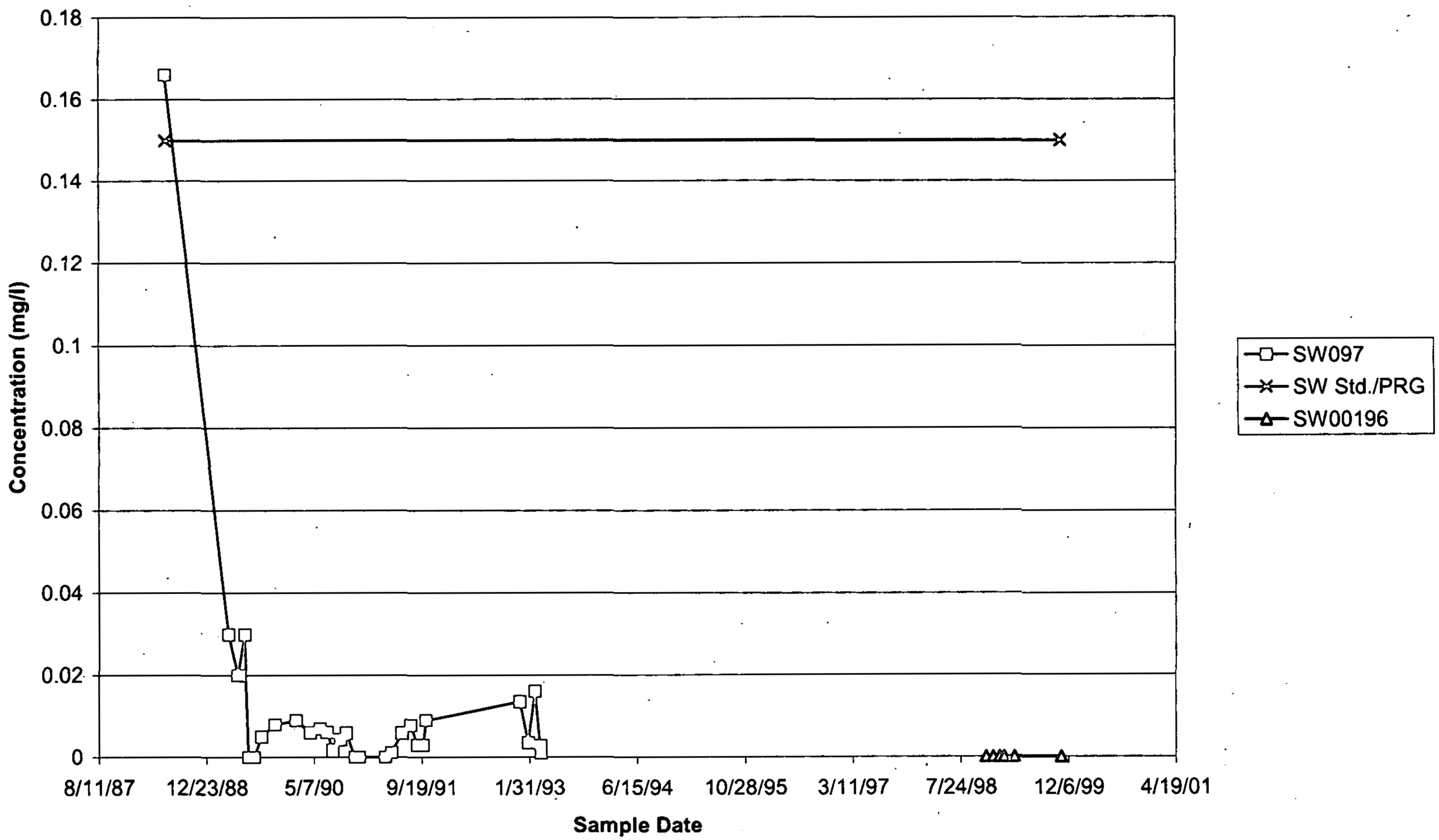


Figure D-20
Radium 226 in Surface Water

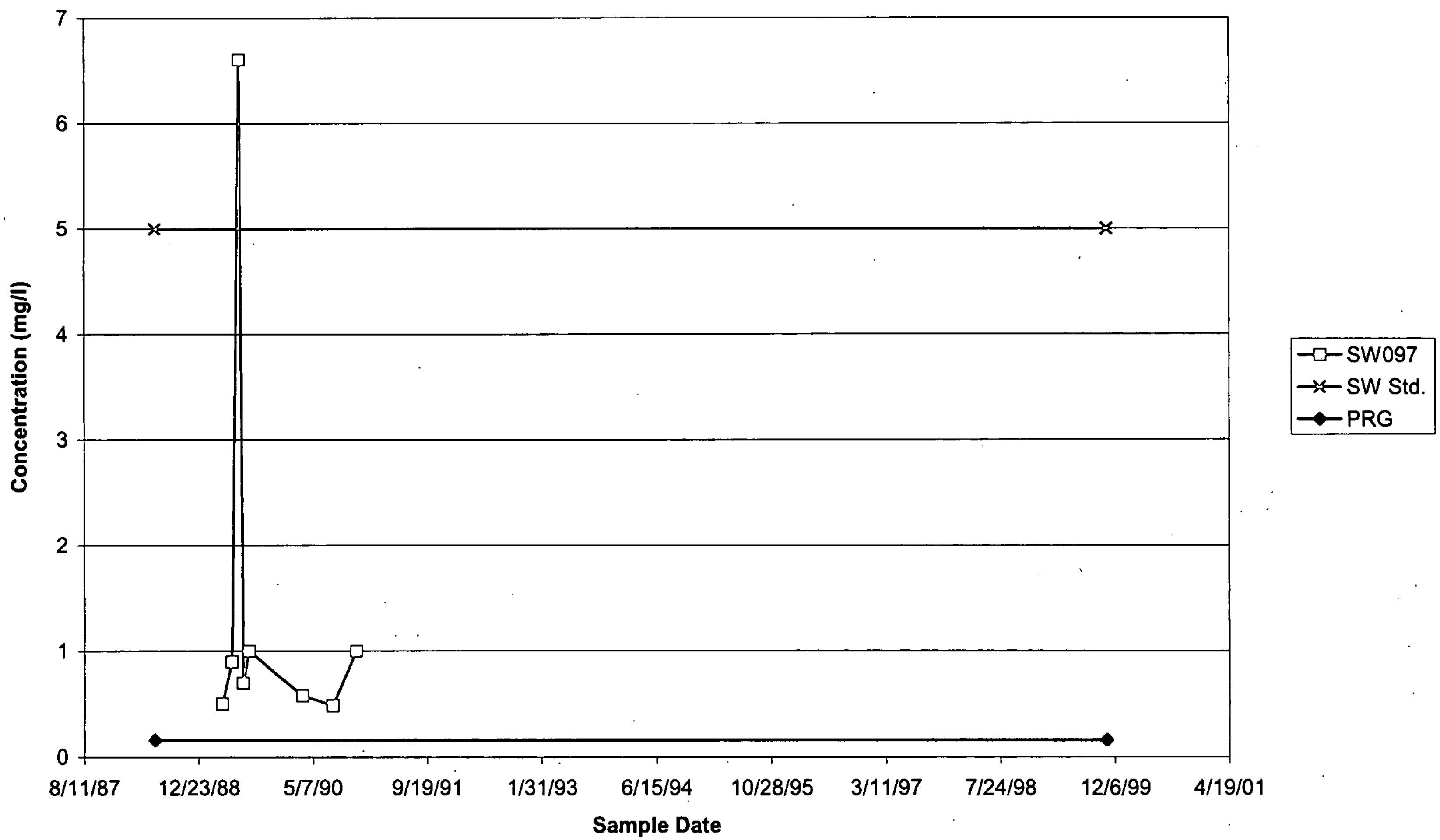


Figure D-21
Radium 228 in Surface Water

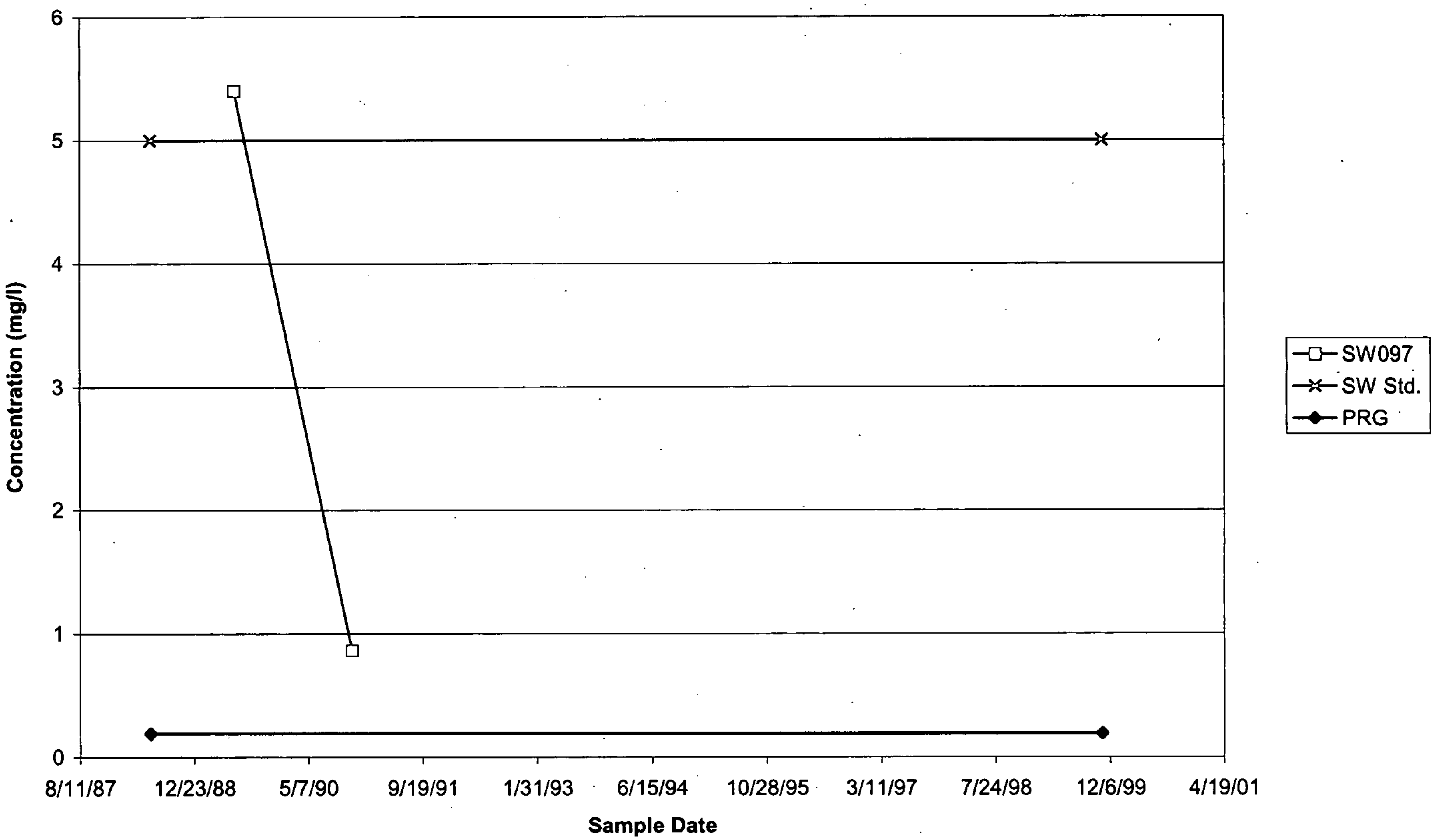
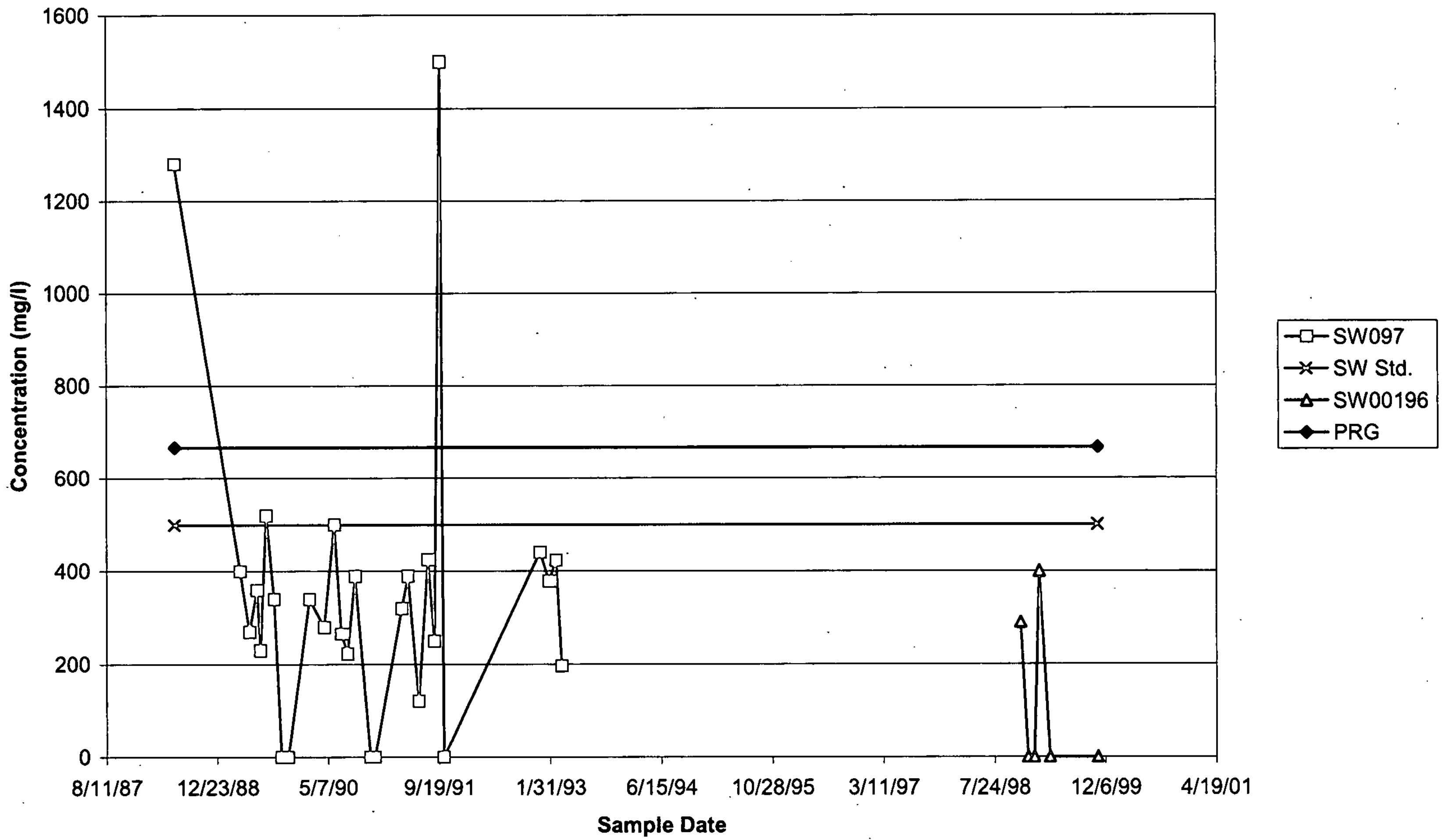


Figure D-22
Tritium in Surface Water



Appendix E

Surface and Subsurface Soil Analytical Data

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
68992	752532	2084328	0.3	0.50	Toluene	230	5	NA	31300000	ug/kg
69192	752536	2084380	0.3	0.50	Toluene	290	5	NA	31300000	ug/kg
SS120594	752960	2084823	0	0.17	Americium-241	0.025	0.008	0.023	76	pCi/g
SS120594	752960	2084823	0	0.17	Plutonium-239/240	0.083	0.005	0.066	50	pCi/g
SS120594	752960	2084823	0	0.17	Barium	150	20	141.26	26400	mg/kg
SS120594	752960	2084823	0	0.17	Nitrite	14.8	0.5	NA	102000	mg/kg
SS120694	752986	2084848	0	0.17	Americium-241	0.044	0.016	0.023	76	pCi/g
SS120694	752986	2084848	0	0.17	Lead	54.7	0.6	54.62	1000	mg/kg
SS120694	752986	2084848	0	0.17	Plutonium-239/240	0.230	0.029	0.066	50	pCi/g
SS120694	752986	2084848	0	0.17	Nickel	16.9	5	14.91	20400	mg/kg
SS120694	752986	2084848	0	0.17	Zinc	81.4	4	73.76	307000	mg/kg
SS120694	752986	2084848	0	0.17	Nitrite	8.52	0.5	NA	102000	mg/kg
SS120694	752986	2084848	0	0.17	Manganese	382	3	365.08	3480	mg/kg
SS120694	752986	2084848	0	0.17	Barium	167	20	141.26	26400	mg/kg
SS120694	752986	2084848	0	0.17	Iron	20100	20	18037	307000	mg/kg
SS120794	752962	2084874	0	0.17	Americium-241	0.045	0.012	0.023	76	pCi/g
SS120794	752962	2084874	0	0.17	Plutonium-239/240	0.100	0.007	0.066	50	pCi/g
SS120794	752962	2084874	0	0.17	Nitrite	4.69	0.5	NA	102000	mg/kg
SS120794	752962	2084874	0	0.17	Barium	146	20	141.26	26400	mg/kg
SS120894	752936	2084849	0	0.17	Nickel	16.6	5	14.91	20400	mg/kg
SS120894	752936	2084849	0	0.17	Copper	20.8	1	18.06	40900	mg/kg
SS120894	752936	2084849	0	0.17	Chromium	23.3	2	16.99	268	mg/kg
SS120894	752936	2084849	0	0.17	Nitrite	9.02	0.5	NA	102000	mg/kg
SS120894	752936	2084849	0	0.17	Vanadium	59.9	8	45.59	7150	mg/kg
SS120894	752936	2084849	0	0.17	Strontium	77.5	40	48.94	613000	mg/kg
SS120894	752936	2084849	0	0.17	Zinc	113	4	73.76	307000	mg/kg
SS120894	752936	2084849	0	0.17	Barium	203	20	141.26	26400	mg/kg
SS120894	752936	2084849	0	0.17	Iron	19000	20	18037	307000	mg/kg

Table 1

Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS120894	752936	2084849	0	0.17	Aluminum	22800	3	16902	228000	mg/kg
SS120994	753080	2084952	0	0.17	Americium-241	0.050	0.012	0.023	76	pCi/g
SS120994	753080	2084952	0	0.17	Plutonium-239/240	0.130	0.012	0.066	50	pCi/g
SS120994	753080	2084952	0	0.17	Chromium	18.4	2	16.99	268	mg/kg
SS120994	753080	2084952	0	0.17	Nitrite	2.47	0.5	NA	102000	mg/kg
SS120994	753080	2084952	0	0.17	Strontium	56.8	40	48.94	613000	mg/kg
SS120994	753080	2084952	0	0.17	Zinc	87.4	4	73.76	307000	mg/kg
SS120994	753080	2084952	0	0.17	Barium	181	20	141.26	26400	mg/kg
SS121094	753106	2084977	0	0.17	Americium-241	0.029	0.018	0.023	76	pCi/g
SS121094	753106	2084977	0	0.17	Plutonium-239/240	0.120	0.011	0.066	50	pCi/g
SS121094	753106	2084977	0	0.17	Chromium	17.5	2	16.99	268	mg/kg
SS121094	753106	2084977	0	0.17	Copper	18.6	1	18.06	40900	mg/kg
SS121094	753106	2084977	0	0.17	Nitrite	1.67	0.5	NA	102000	mg/kg
SS121094	753106	2084977	0	0.17	Strontium	60.9	40	48.94	613000	mg/kg
SS121094	753106	2084977	0	0.17	Zinc	87.3	4	73.76	307000	mg/kg
SS121094	753106	2084977	0	0.17	Barium	200	20	141.26	26400	mg/kg
SS121094	753106	2084977	0	0.17	Iron	18400	20	18037	307000	mg/kg
SS121194	753080	2085002	0	0.17	Copper	20.9	1	18.06	40900	mg/kg
SS121194	753080	2085002	0	0.17	Nitrite	3.9	0.5	NA	102000	mg/kg
SS121194	753080	2085002	0	0.17	Strontium	64.5	40	48.94	613000	mg/kg
SS121194	753080	2085002	0	0.17	Barium	243	20	141.26	26400	mg/kg
SS121294	753056	2084978	0	0.17	Americium-241	0.032	0.009	0.023	76	pCi/g
SS121294	753056	2084978	0	0.17	Plutonium-239/240	0.110	0.011	0.066	50	pCi/g
SS121294	753056	2084978	0	0.17	Copper	18.9	1	18.06	40900	mg/kg
SS121294	753056	2084978	0	0.17	Strontium	53.4	40	48.94	613000	mg/kg
SS121294	753056	2084978	0	0.17	Nitrite	5.99	0.5	NA	102000	mg/kg
SS121294	753056	2084978	0	0.17	Zinc	81.2	4	73.76	307000	mg/kg
SS121294	753056	2084978	0	0.17	Barium	171	20	141.26	26400	mg/kg

Table 1

Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS121394	753152	2084868	0	0.17	Americium-241	0.027	0.011	0.023	76	pCi/g
SS121394	753152	2084868	0	0.17	Plutonium-239/240	0.150	0.002	0.066	50	pCi/g
SS121394	753152	2084868	0	0.17	Strontium	54.1	40	48.94	613000	mg/kg
SS121394	753152	2084868	0	0.17	Nickel	23.8	5	14.91	20400	mg/kg
SS121394	753152	2084868	0	0.17	Nitrite	16	0.5	NA	102000	mg/kg
SS121394	753152	2084868	0	0.17	Zinc	92	4	73.76	307000	mg/kg
SS121394	753152	2084868	0	0.17	Barium	222	20	141.26	26400	mg/kg
SS121394	753152	2084868	0	0.17	Copper	640	1	18.06	40900	mg/kg
SS121494	753178	2084892	0	0.17	Americium-241	0.039	0.014	0.023	76	pCi/g
SS121494	753178	2084892	0	0.17	Plutonium-239/240	0.110	0.011	0.066	50	pCi/g
SS121494	753178	2084892	0	0.17	Cobalt	12.9	10	10.91	1550	mg/kg
SS121494	753178	2084892	0	0.17	Nickel	21.5	5	14.91	20400	mg/kg
SS121494	753178	2084892	0	0.17	Zinc	80.4	4	73.76	307000	mg/kg
SS121494	753178	2084892	0	0.17	Nitrite	6.7	0.5	NA	102000	mg/kg
SS121494	753178	2084892	0	0.17	Strontium	59	40	48.94	613000	mg/kg
SS121494	753178	2084892	0	0.17	Barium	239	20	141.26	26400	mg/kg
SS121494	753178	2084892	0	0.17	Iron	20800	20	18037	307000	mg/kg
SS121594	753154	2084918	0	0.17	Plutonium-239/240	0.072	0.017	0.066	50	pCi/g
SS121594	753154	2084918	0	0.17	Americium-241	0.033	0.01	0.023	76	pCi/g
SS121594	753154	2084918	0	0.17	Beryllium	1.4	1	0.966	921	mg/kg
SS121594	753154	2084918	0	0.17	Strontium	50.9	40	48.94	613000	mg/kg
SS121594	753154	2084918	0	0.17	Nickel	18.1	5	14.91	20400	mg/kg
SS121594	753154	2084918	0	0.17	Nitrite	14.1	0.5	NA	102000	mg/kg
SS121594	753154	2084918	0	0.17	Barium	253	20	141.26	26400	mg/kg
SS121594	753154	2084918	0	0.17	Manganese	874	3	365.08	3480	mg/kg
SS121594	753154	2084918	0	0.17	Iron	59600	20	18037	307000	mg/kg
SS121694	753128	2084894	0	0.17	Americium-241	0.064	0.026	0.023	76	pCi/g
SS121694	753128	2084894	0	0.17	Beryllium	1.1	1	0.966	921	mg/kg

Table 1

Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS121694	753128	2084894	0	0.17	Plutonium-239/240	0.350	0.011	0.066	50	pCi/g
SS121694	753128	2084894	0	0.17	Nickel	15.9	5	14.91	20400	mg/kg
SS121694	753128	2084894	0	0.17	Copper	19.6	1	18.06	40900	mg/kg
SS121694	753128	2084894	0	0.17	Strontium	58	40	48.94	613000	mg/kg
SS121694	753128	2084894	0	0.17	Nitrite	13.1	0.5	NA	102000	mg/kg
SS121694	753128	2084894	0	0.17	Zinc	93.1	4	73.76	307000	mg/kg
SS121694	753128	2084894	0	0.17	Barium	195	20	141.26	26400	mg/kg
SS604092	752800	2084079	0	0.17	Mercury	0.16	0.1	0.134	25200	mg/kg
SS604092	752800	2084079	0	0.17	Antimony	11.9	4	0.47	409	mg/kg
SS604092	752800	2084079	0	0.17	Tin	58	40	2.9	613000	mg/kg
SS604092	752800	2084079	0	0.17	Barium	208	20	141.26	26400	mg/kg
SS604192	752795	2084181	0	0.17	Mercury	0.15	0.1	0.134	25200	mg/kg
SS604192	752795	2084181	0	0.17	Antimony	12.3	4	0.47	409	mg/kg
SS604192	752795	2084181	0	0.17	Barium	187	20	141.26	26400	mg/kg
SS604392	752780	2084133	0	0.17	Antimony	14.3	4	0.47	409	mg/kg
SS604392	752780	2084133	0	0.17	Tin	65.9	40	2.9	613000	mg/kg
SS604392	752780	2084133	0	0.17	Barium	208	20	141.26	26400	mg/kg
SS604492	752776	2084231	0	0.17	Plutonium-239/240	0.073	0	0.066	50	pCi/g
SS604492	752776	2084231	0	0.17	Barium	170	20	141.26	26400	mg/kg
SS604592	752741	2084082	0	0.17	Antimony	15.1	4	0.47	409	mg/kg
SS604592	752741	2084082	0	0.17	Strontium	64	40	48.94	613000	mg/kg
SS604592	752741	2084082	0	0.17	Tin	72.3	40	2.9	613000	mg/kg
SS604592	752741	2084082	0	0.17	Barium	305	20	141.26	26400	mg/kg
SS604692	752747	2084181	0	0.17	Strontium	49.2	40	48.94	613000	mg/kg
SS604692	752747	2084181	0	0.17	Vanadium	46.7	8	45.59	7150	mg/kg
SS604692	752747	2084181	0	0.17	Cobalt	13.3	10	10.91	1550	mg/kg
SS604692	752747	2084181	0	0.17	Antimony	11.9	4	0.47	409	mg/kg
SS604692	752747	2084181	0	0.17	Iron	18200	20	18037	307000	mg/kg

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS604692	752747	2084181	0	0.17	Barium	474	20	141.26	26400	mg/kg
SS604692	752747	2084181	0	0.17	Aluminum	18600	3	16902	228000	mg/kg
SS604792	752754	2084281	0	0.17	Cobalt	11.2	10	10.91	1550	mg/kg
SS604792	752754	2084281	0	0.17	Barium	177	20	141.26	26400	mg/kg
SS604892	752728	2084131	0	0.17	Cobalt	11.3	10	10.91	1550	mg/kg
SS604892	752728	2084131	0	0.17	Strontium	53.9	40	48.94	613000	mg/kg
SS604892	752728	2084131	0	0.17	Barium	342	20	141.26	26400	mg/kg
SS604992	752727	2084234	0	0.17	Plutonium-239/240	0.096	0	0.066	50	pCi/g
SS604992	752727	2084234	0	0.17	Barium	238	20	141.26	26400	mg/kg
SS604992	752727	2084234	0	0.17	Antimony	348	4	0.47	409	mg/kg
SS605092	752695	2084082	0	0.17	Strontium	55.6	40	48.94	613000	mg/kg
SS605092	752695	2084082	0	0.17	Barium	187	20	141.26	26400	mg/kg
SS605192	752701	2084182	0	0.17	Nickel	16.5	5	14.91	20400	mg/kg
SS605192	752701	2084182	0	0.17	Antimony	13.3	4	0.47	409	mg/kg
SS605192	752701	2084182	0	0.17	Barium	401	20	141.26	26400	mg/kg
SS605292	752705	2084282	0	0.17	Chromium	22.4	2	16.99	268	mg/kg
SS605292	752705	2084282	0	0.17	Barium	284	20	141.26	26400	mg/kg
SS605392	752482	2084470	0	0.17	Americium-241	0.044	0	0.023	76	pCi/g
SS605392	752482	2084470	0	0.17	Nickel	15.8	5	14.91	20400	mg/kg
SS605392	752482	2084470	0	0.17	Barium	154	20	141.26	26400	mg/kg
SS605392	752482	2084470	0	0.17	Antimony	19.4	4	0.47	409	mg/kg
SS605492	752455	2084618	0	0.17	Americium-241	0.064	0	0.023	76	pCi/g
SS605492	752455	2084618	0	0.17	Lead	68.7	3	54.62	1000	mg/kg
SS605492	752455	2084618	0	0.17	Antimony	21.1	4	0.47	409	mg/kg
SS605492	752455	2084618	0	0.17	Barium	162	20	141.26	26400	mg/kg
SS605592	752409	2084538	0	0.17	Americium-241	0.038	0	0.023	76	pCi/g
SS605592	752409	2084538	0	0.17	Barium	146	20	141.26	26400	mg/kg
SS605592	752409	2084538	0	0.17	Antimony	20.9	4	0.47	409	mg/kg

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS605692	752434	2084671	0	0.17	Americium-241	0.057	0	0.023	76	pCi/g
SS605692	752434	2084671	0	0.17	Plutonium-239/240	0.192	0.017	0.066	50	pCi/g
SS605692	752434	2084671	0	0.17	Lead	57.2	3	54.62	1000	mg/kg
SS605692	752434	2084671	0	0.17	Nickel	18.4	5	14.91	20400	mg/kg
SS605692	752434	2084671	0	0.17	Antimony	18	4	0.47	409	mg/kg
SS605692	752434	2084671	0	0.17	Barium	167	20	141.26	26400	mg/kg
SS605692	752434	2084671	0	0.17	Zinc	119	4	73.76	307000	mg/kg
SS605692	752434	2084671	0	0.17	Manganese	429	3	365.08	3480	mg/kg
SS605792	752364	2084467	0	0.17	Americium-241	0.046	0	0.023	76	pCi/g
SS605792	752364	2084467	0	0.17	Plutonium-239/240	0.154		0.066	50	pCi/g
SS605792	752364	2084467	0	0.17	Beryllium	1.2	1	0.966	921	mg/kg
SS605792	752364	2084467	0	0.17	Cobalt	11.2	10	10.91	1550	mg/kg
SS605792	752364	2084467	0	0.17	Lead	65.1	3	54.62	1000	mg/kg
SS605792	752364	2084467	0	0.17	Antimony	31.7	4	0.47	409	mg/kg
SS605792	752364	2084467	0	0.17	Barium	183	20	141.26	26400	mg/kg
SS605792	752364	2084467	0	0.17	Manganese	435	3	365.08	3480	mg/kg
SS605892	752366	2084603	0	0.17	Americium-241	0.069	0	0.023	76	pCi/g
SS605892	752366	2084603	0	0.17	Plutonium-239/240	0.242		0.066	50	pCi/g
SS605892	752366	2084603	0	0.17	Nickel	17.7	5	14.91	20400	mg/kg
SS605892	752366	2084603	0	0.17	Lead	58.4	3	54.62	1000	mg/kg
SS605892	752366	2084603	0	0.17	Manganese	372	3	365.08	3480	mg/kg
SS605892	752366	2084603	0	0.17	Antimony	14.7	4	0.47	409	mg/kg
SS605892	752366	2084603	0	0.17	Barium	170	20	141.26	26400	mg/kg
SS605992	752323	2084536	0	0.17	Americium-241	0.053	0	0.023	76	pCi/g
SS605992	752323	2084536	0	0.17	Plutonium-239/240	0.173	0	0.066	50	pCi/g
SS605992	752323	2084536	0	0.17	Barium	153	20	141.26	26400	mg/kg
SS605992	752323	2084536	0	0.17	Antimony	17.9	4	0.47	409	mg/kg
SS606092	752333	2084674	0	0.17	Plutonium-239/240	0.295	0	0.066	50	pCi/g

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS606092	752333	2084674	0	0.17	Copper	18.3	1	18.06	40900	mg/kg
SS606092	752333	2084674	0	0.17	Americium-241	0.565	0	0.023	76	pCi/g
SS606092	752333	2084674	0	0.17	Antimony	18.9	4	0.47	409	mg/kg
SS606092	752333	2084674	0	0.17	Barium	161	20	141.26	26400	mg/kg
SS700093	752788	2084587	0.083	0.17	Barium	146	20	141.26	26400	mg/kg
SS700193	752739	2084587	0.083	0.17	Nickel	15.3	5	14.91	20400	mg/kg
SS700193	752739	2084587	0.083	0.17	Nitrite	6	1	NA	102000	mg/kg
SS700193	752739	2084587	0.083	0.17	Barium	156	20	141.26	26400	mg/kg
SS700293	752694	2084538	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS700293	752694	2084538	0.083	0.17	Manganese	435	3	365.08	3480	mg/kg
SS700293	752694	2084538	0.083	0.17	Iron	22300	1	18037	307000	mg/kg
SS700393	752743	2084537	0.083	0.17	Nickel	15.4	5	14.91	20400	mg/kg
SS700393	752743	2084537	0.083	0.17	Barium	160	20	141.26	26400	mg/kg
SS700493	752791	2084535	0.083	0.17	Nitrite	10	1	NA	102000	mg/kg
SS700493	752791	2084535	0.083	0.17	Manganese	553	3	365.08	3480	mg/kg
SS700593	752791	2084486	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS700593	752791	2084486	0.083	0.17	Zinc	86.6	4	73.76	307000	mg/kg
SS700593	752791	2084486	0.083	0.17	Lead	77.6	6.3	54.62	1000	mg/kg
SS700593	752791	2084486	0.083	0.17	Barium	200	20	141.26	26400	mg/kg
SS700593	752791	2084486	0.083	0.17	Manganese	1370	3	365.08	3480	mg/kg
SS700693	752741	2084488	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS700693	752741	2084488	0.083	0.17	Barium	170	20	141.26	26400	mg/kg
SS700793	752692	2084489	0.083	0.17	Plutonium-239/240	0.247	0.014	0.066	50	pCi/g
SS700793	752692	2084489	0.083	0.17	Antimony	6.1	4	0.47	409	mg/kg
SS700793	752692	2084489	0.083	0.17	Iron	20500	0.93	18037	307000	mg/kg
SS700893	752694	2084440	0.083	0.17	Americium-241	0.031	0	0.023	76	pCi/g
SS700893	752694	2084440	0.083	0.17	Plutonium-239/240	0.176	0	0.066	50	pCi/g
SS700893	752694	2084440	0.083	0.17	Nitrite	4	1	NA	102000	mg/kg

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS700893	752694	2084440	0.083	0.17	Barium	174	20	141.26	26400	mg/kg
SS700993	752743	2084438	0.083	0.17	Americium-241	0.063	0	0.023	76	pCi/g
SS700993	752743	2084438	0.083	0.17	Nitrite	5	1	NA	102000	mg/kg
SS700993	752743	2084438	0.083	0.17	Barium	192	20	141.26	26400	mg/kg
SS701193	752842	2084437	0.083	0.17	Americium-241	0.037	0.01	0.023	76	pCi/g
SS701193	752842	2084437	0.083	0.17	Plutonium-239/240	0.160	0.06	0.066	50	pCi/g
SS701193	752842	2084437	0.083	0.17	Nitrite	8	1	NA	102000	mg/kg
SS701193	752842	2084437	0.083	0.17	Barium	201	20	141.26	26400	mg/kg
SS701193	752842	2084437	0.083	0.17	Manganese	1290	3	365.08	3480	mg/kg
SS701293	752844	2084388	0.083	0.17	Nitrite	7	1	NA	102000	mg/kg
SS701293	752844	2084388	0.083	0.17	Manganese	377	3	365.08	3480	mg/kg
SS701393	752795	2084390	0.083	0.17	Americium-241	0.042	0.009	0.023	76	pCi/g
SS701393	752795	2084390	0.083	0.17	Plutonium-239/240	0.130	0.06	0.066	50	pCi/g
SS701393	752795	2084390	0.083	0.17	Nitrite	7	1	NA	102000	mg/kg
SS701393	752795	2084390	0.083	0.17	Manganese	540	3	365.08	3480	mg/kg
SS701493	752746	2084393	0.083	0.17	Americium-241	0.023	0	0.023	76	pCi/g
SS701493	752746	2084393	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS701493	752746	2084393	0.083	0.17	Antimony	7.2	4	0.47	409	mg/kg
SS701493	752746	2084393	0.083	0.17	Barium	172	20	141.26	26400	mg/kg
SS701593	752697	2084395	0.083	0.17	Nickel	15.4	5	14.91	20400	mg/kg
SS701593	752697	2084395	0.083	0.17	Antimony	5.2	4	0.47	409	mg/kg
SS701593	752697	2084395	0.083	0.17	Cobalt	15.7	10	10.91	1550	mg/kg
SS701593	752697	2084395	0.083	0.17	Barium	166	20	141.26	26400	mg/kg
SS701593	752697	2084395	0.083	0.17	Iron	22500	0.96	18037	307000	mg/kg
SS701693	752698	2084345	0.083	0.17	Antimony	6.8	4	0.47	409	mg/kg
SS701693	752698	2084345	0.083	0.17	Barium	188	20	141.26	26400	mg/kg
SS701793	752747	2084344	0.083	0.17	Nitrite	4	1	NA	102000	mg/kg
SS701793	752747	2084344	0.083	0.17	Barium	187	20	141.26	26400	mg/kg

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS701893	752798	2084343	0.083	0.17	Nitrite	4	1	NA	102000	mg/kg
SS701993	752846	2084343	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS702093	752848	2084293	0.083	0.17	Plutonium-239/240	0.092	0.01	0.066	50	pCi/g
SS702093	752848	2084293	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS702193	752799	2084293	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS702293	752749	2084292	0.083	0.17	Nitrite	4	1	NA	102000	mg/kg
SS702293	752749	2084292	0.083	0.17	Barium	225	20	141.26	26400	mg/kg
SS702393	752700	2084291	0.083	0.17	Barium	346	20	141.26	26400	mg/kg
SS702493	752699	2084241	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS702493	752699	2084241	0.083	0.17	Barium	244	20	141.26	26400	mg/kg
SS702593	752748	2084239	0.083	0.17	Americium-241	0.033	0.008	0.023	76	pCi/g
SS702593	752748	2084239	0.083	0.17	Plutonium-239/240	0.097	0.02	0.066	50	pCi/g
SS702593	752748	2084239	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS702593	752748	2084239	0.083	0.17	Barium	157	20	141.26	26400	mg/kg
SS702693	752797	2084237	0.083	0.17	Nitrite	6	1	NA	102000	mg/kg
SS702793	752846	2084234	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS702793	752846	2084234	0.083	0.17	Barium	209	20	141.26	26400	mg/kg
SS702893	752846	2084184	0.083	0.17	Americium-241	0.025	0	0.023	76	pCi/g
SS702893	752846	2084184	0.083	0.17	Plutonium-239/240	0.082	0	0.066	50	pCi/g
SS702993	752798	2084186	0.083	0.17	Americium-241	0.027	0	0.023	76	pCi/g
SS702993	752798	2084186	0.083	0.17	Plutonium-239/240	0.085	0	0.066	50	pCi/g
SS702993	752798	2084186	0.083	0.17	Nitrite	8	1	NA	102000	mg/kg
SS702993	752798	2084186	0.083	0.17	Barium	170	20	141.26	26400	mg/kg
SS703093	752750	2084186	0.083	0.17	Beryllium	1.2	0.21	0.966	921	mg/kg
SS703093	752750	2084186	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS703093	752750	2084186	0.083	0.17	Chromium	21.3	2	16.99	268	mg/kg
SS703093	752750	2084186	0.083	0.17	Vanadium	51.8	8	45.59	7150	mg/kg
SS703093	752750	2084186	0.083	0.17	Barium	286	20	141.26	26400	mg/kg

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS703093	752750	2084186	0.083	0.17	Aluminum	19200	3	16902	228000	mg/kg
SS703193	752700	2084189	0.083	0.17	Americium-241	0.028	0	0.023	76	pCi/g
SS703193	752700	2084189	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS703193	752700	2084189	0.083	0.17	Barium	222	20	141.26	26400	mg/kg
SS703293	752701	2084140	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS703293	752701	2084140	0.083	0.17	Barium	377	20	141.26	26400	mg/kg
SS703393	752751	2084138	0.083	0.17	Nitrite	7	1	NA	102000	mg/kg
SS703393	752751	2084138	0.083	0.17	Barium	172	20	141.26	26400	mg/kg
SS703493	752800	2084134	0.083	0.17	Chromium	17.1	2	16.99	268	mg/kg
SS703493	752800	2084134	0.083	0.17	Nickel	15.6	5	14.91	20400	mg/kg
SS703493	752800	2084134	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS703493	752800	2084134	0.083	0.17	Barium	228	20	141.26	26400	mg/kg
SS703593	752803	2084085	0.083	0.17	Barium	311	20	141.26	26400	mg/kg
SS703693	752754	2084085	0.083	0.17	Cobalt	11	10	10.91	1550	mg/kg
SS703693	752754	2084085	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS703693	752754	2084085	0.083	0.17	Barium	269	20	141.26	26400	mg/kg
SS703793	752704	2084088	0.083	0.17	Americium-241	1.076	0.02	0.023	76	pCi/g
SS703793	752704	2084088	0.083	0.17	Nitrite	4	1	NA	102000	mg/kg
SS703793	752704	2084088	0.083	0.17	Barium	229	20	141.26	26400	mg/kg
SS703893	752705	2084039	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS703893	752705	2084039	0.083	0.17	Barium	241	20	141.26	26400	mg/kg
SS703993	752755	2084039	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS703993	752755	2084039	0.083	0.17	Barium	180	20	141.26	26400	mg/kg
SS704093	752804	2084035	0.083	0.17	Chromium	19.9	2	16.99	268	mg/kg
SS704093	752804	2084035	0.083	0.17	Nitrite	16	1	NA	102000	mg/kg
SS704093	752804	2084035	0.083	0.17	Barium	172	20	141.26	26400	mg/kg
SS704093	752804	2084035	0.083	0.17	Aluminum	18800	3	16902	228000	mg/kg
SS704193	752805	2083985	0.083	0.17	Barium	186	20	141.26	26400	mg/kg

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS704293	752756	2083986	0.083	0.17	Americium-241	0.050	0	0.023	76	pCi/g
SS704293	752756	2083986	0.083	0.17	Plutonium-239/240	0.469	0	0.066	50	pCi/g
SS704293	752756	2083986	0.083	0.17	Barium	235	20	141.26	26400	mg/kg
SS704493	752705	2083944	0.083	0.17	Nickel	16.7	5	14.91	20400	mg/kg
SS704593	752755	2083942	0.083	0.17	Nickel	16.6	5	14.91	20400	mg/kg
SS704593	752755	2083942	0.083	0.17	Chromium	20.9	2	16.99	268	mg/kg
SS704593	752755	2083942	0.083	0.17	Iron	18600	1.1	18037	307000	mg/kg
SS704593	752755	2083942	0.083	0.17	Aluminum	18000	3	16902	228000	mg/kg
SS704693	752804	2083939	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS704693	752804	2083939	0.083	0.17	Barium	178	20	141.26	26400	mg/kg
SS704793	752853	2083937	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS704793	752853	2083937	0.083	0.17	Barium	349	20	141.26	26400	mg/kg
SS704893	752902	2083930	0.083	0.17	Barium	179	20	141.26	26400	mg/kg
SS705093	753001	2083919	0.083	0.17	Barium	154	20	141.26	26400	mg/kg
SS705193	753051	2083914	0.083	0.17	Copper	23.6	1	18.06	40900	mg/kg
SS705193	753051	2083914	0.083	0.17	Iron	18900	1.2	18037	307000	mg/kg
SS705193	753051	2083914	0.083	0.17	Barium	1120	20	141.26	26400	mg/kg
SS705293	753048	2083969	0.083	0.17	Copper	19.7	1	18.06	40900	mg/kg
SS705293	753048	2083969	0.083	0.17	Nickel	19	5	14.91	20400	mg/kg
SS705293	753048	2083969	0.083	0.17	Antimony	5.8	4	0.47	409	mg/kg
SS705293	753048	2083969	0.083	0.17	Barium	165	20	141.26	26400	mg/kg
SS705293	753048	2083969	0.083	0.17	Vanadium	86.2	8	45.59	7150	mg/kg
SS705293	753048	2083969	0.083	0.17	Manganese	518	3	365.08	3480	mg/kg
SS705293	753048	2083969	0.083	0.17	Iron	26100	1	18037	307000	mg/kg
SS705493	752951	2083978	0.083	0.17	Nitrite	4	1	NA	102000	mg/kg
SS705493	752951	2083978	0.083	0.17	Barium	183	20	141.26	26400	mg/kg
SS705593	752901.8	2083980	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS705593	752901.8	2083980	0.083	0.17	Barium	243	20	141.26	26400	mg/kg

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS705693	752904	2084029	0.083	0.17	Nitrite	5	1	NA	102000	mg/kg
SS705693	752904	2084029	0.083	0.17	Barium	182	20	141.26	26400	mg/kg
SS705793	752952	2084024	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS705793	752952	2084024	0.083	0.17	Barium	270	20	141.26	26400	mg/kg
SS705893	753002	2084022	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS705893	753002	2084022	0.083	0.17	Barium	204	20	141.26	26400	mg/kg
SS705993	753052	2084018	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS705993	753052	2084018	0.083	0.17	Barium	164	20	141.26	26400	mg/kg
SS706093	753062	2084068	0.083	0.17	Vanadium	68.2	8	45.59	7150	mg/kg
SS706093	753062	2084068	0.083	0.17	Barium	207	20	141.26	26400	mg/kg
SS706093	753062	2084068	0.083	0.17	Iron	20400	0.98	18037	307000	mg/kg
SS706193	753013	2084070	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS706293	752963	2084073	0.083	0.17	Plutonium-239/240	0.071	0	0.066	50	pCi/g
SS706293	752963	2084073	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS706293	752963	2084073	0.083	0.17	Barium	220	20	141.26	26400	mg/kg
SS706393	752915	2084077	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS706393	752915	2084077	0.083	0.17	Barium	155	20	141.26	26400	mg/kg
SS706493	752940	2084121	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS706493	752940	2084121	0.083	0.17	Barium	157	20	141.26	26400	mg/kg
SS706593	752971	2084121	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS706593	752971	2084121	0.083	0.17	Barium	149	20	141.26	26400	mg/kg
SS706793	753068	2084107	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS706793	753068	2084107	0.083	0.17	Barium	150	20	141.26	26400	mg/kg
SS706993	753165	2084141	0.083	0.17	Barium	448	20	141.26	26400	mg/kg
SS707093	753118	2084150	0.083	0.17	Nitrite	4	1	NA	102000	mg/kg
SS707093	753118	2084150	0.083	0.17	Barium	260	20	141.26	26400	mg/kg
SS707193	753070	2084155	0.083	0.17	Nitrite	7	1	NA	102000	mg/kg
SS707193	753070	2084155	0.083	0.17	Barium	177	20	141.26	26400	mg/kg

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS707393	752975	2084157	0.083	0.17	Copper	18.6	1	18.06	40900	mg/kg
SS707393	752975	2084157	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS707393	752975	2084157	0.083	0.17	Zinc	101	4	73.76	307000	mg/kg
SS707393	752975	2084157	0.083	0.17	Barium	226	20	141.26	26400	mg/kg
SS707493	752978	2084208	0.083	0.17	Barium	166	20	141.26	26400	mg/kg
SS707593	753027	2084203	0.083	0.17	Barium	186	20	141.26	26400	mg/kg
SS707693	753076	2084204	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS707693	753076	2084204	0.083	0.17	Barium	197	20	141.26	26400	mg/kg
SS707793	753124	2084201	0.083	0.17	Nitrite	6	1	NA	102000	mg/kg
SS707793	753124	2084201	0.083	0.17	Barium	176	20	141.26	26400	mg/kg
SS707893	753173	2084204	0.083	0.17	Plutonium-239/240	0.068	0	0.066	50	pCi/g
SS707893	753173	2084204	0.083	0.17	Cobalt	11.4	10	10.91	1550	mg/kg
SS707893	753173	2084204	0.083	0.17	Nickel	17.5	5	14.91	20400	mg/kg
SS707893	753173	2084204	0.083	0.17	Barium	186	20	141.26	26400	mg/kg
SS707893	753173	2084204	0.083	0.17	Iron	18100	1.2	18037	307000	mg/kg
SS707893	753173	2084204	0.083	0.17	Lead	122	6.4	54.62	1000	mg/kg
SS707993	753177	2084253	0.083	0.17	Chromium	17.1	2	16.99	268	mg/kg
SS707993	753177	2084253	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS707993	753177	2084253	0.083	0.17	Barium	334	20	141.26	26400	mg/kg
SS708093	753128	2084256	0.083	0.17	Americium-241	0.023	0	0.023	76	pCi/g
SS708093	753128	2084256	0.083	0.17	Beryllium	1.1	0.074	0.966	921	mg/kg
SS708093	753128	2084256	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS708093	753128	2084256	0.083	0.17	Barium	409	20	141.26	26400	mg/kg
SS708193	753080	2084258	0.083	0.17	Nitrite	4	1	NA	102000	mg/kg
SS708193	753080	2084258	0.083	0.17	Barium	193	20	141.26	26400	mg/kg
SS708293	753028	2084260	0.083	0.17	Nitrite	14	1	NA	102000	mg/kg
SS708293	753028	2084260	0.083	0.17	Zinc	95.6	4	73.76	307000	mg/kg
SS708293	753028	2084260	0.083	0.17	Barium	291	20	141.26	26400	mg/kg

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS708393	753081	2084307	0.083	0.17	Americium-241	0.038	0	0.023	76	pCi/g
SS708393	753081	2084307	0.083	0.17	Nitrite	5	1	NA	102000	mg/kg
SS708393	753081	2084307	0.083	0.17	Barium	279	20	141.26	26400	mg/kg
SS708493	753129	2084302	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS708493	753129	2084302	0.083	0.17	Barium	385	20	141.26	26400	mg/kg
SS708593	753179	2084302	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS708593	753179	2084302	0.083	0.17	Barium	253	20	141.26	26400	mg/kg
SS708693	753178	2084360	0.083	0.17	Beryllium	1.1	0.07	0.966	921	mg/kg
SS708693	753178	2084360	0.083	0.17	Barium	285	20	141.26	26400	mg/kg
SS708793	753130	2084362	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS708793	753130	2084362	0.083	0.17	Barium	183	20	141.26	26400	mg/kg
SS708893	753084	2084364	0.083	0.17	Zinc	74.6	4	73.76	307000	mg/kg
SS708893	753084	2084364	0.083	0.17	Nitrite	6	1	NA	102000	mg/kg
SS708893	753084	2084364	0.083	0.17	Barium	168	20	141.26	26400	mg/kg
SS708893	753084	2084364	0.083	0.17	Lead	167	17.2	54.62	1000	mg/kg
SS709093	753132	2084410	0.083	0.17	Americium-241	0.035	0	0.023	76	pCi/g
SS709093	753132	2084410	0.083	0.17	Plutonium-239/240	0.109	0	0.066	50	pCi/g
SS709093	753132	2084410	0.083	0.17	Zinc	77.3	4	73.76	307000	mg/kg
SS709093	753132	2084410	0.083	0.17	Nitrite	6	1	NA	102000	mg/kg
SS709093	753132	2084410	0.083	0.17	Barium	157	20	141.26	26400	mg/kg
SS709093	753132	2084410	0.083	0.17	Manganese	436	3	365.08	3480	mg/kg
SS709193	753182	2084412	0.083	0.17	Barium	155	20	141.26	26400	mg/kg
SS709293	753232	2084412	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS709293	753232	2084412	0.083	0.17	Barium	241	20	141.26	26400	mg/kg
SS709393	753235	2084462	0.083	0.17	Plutonium-239/240	0.071	0	0.066	50	pCi/g
SS709393	753235	2084462	0.083	0.17	Vanadium	45.7	8	45.59	7150	mg/kg
SS709393	753235	2084462	0.083	0.17	Beryllium	1.1	0.074	0.966	921	mg/kg
SS709393	753235	2084462	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS709393	753235	2084462	0.083	0.17	Barium	360	20	141.26	26400	mg/kg
SS709493	753188	2084461	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS709493	753188	2084461	0.083	0.17	Barium	186	20	141.26	26400	mg/kg
SS709593	753270	2084613	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS709593	753270	2084613	0.083	0.17	Barium	171	20	141.26	26400	mg/kg
SS709693	753171	2084626	0.083	0.17	Americium-241	0.025	0	0.023	76	pCi/g
SS709693	753171	2084626	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS709693	753171	2084626	0.083	0.17	Barium	303	20	141.26	26400	mg/kg
SS709793	753074	2084649	0.083	0.17	Plutonium-239/240	0.081	0.005	0.066	50	pCi/g
SS709793	753074	2084649	0.083	0.17	Nitrite	4	1	NA	102000	mg/kg
SS709893	752978	2084675	0.083	0.17	Nitrite	4	1	NA	102000	mg/kg
SS709993	752882	2084704	0.083	0.17	Barium	154	20	141.26	26400	mg/kg
SS709993	752882	2084704	0.083	0.17	Nitrite	18	1	NA	102000	mg/kg
SS710093	752753	2084721	0.083	0.17	Beryllium	1.1	0.23	0.966	921	mg/kg
SS710093	752753	2084721	0.083	0.17	Barium	167	20	141.26	26400	mg/kg
SS710193	752653	2084602	0.083	0.17	Americium-241	0.046	0	0.023	76	pCi/g
SS710193	752653	2084602	0.083	0.17	Plutonium-239/240	0.202	0	0.066	50	pCi/g
SS710193	752653	2084602	0.083	0.17	Barium	144	20	141.26	26400	mg/kg
SS710193	752653	2084602	0.083	0.17	Nitrite	10	1	NA	102000	mg/kg
SS710293	752620	2084725	0.083	0.17	Plutonium-239/240	0.068	0	0.066	50	pCi/g
SS710293	752620	2084725	0.083	0.17	Americium-241	0.027	0	0.023	76	pCi/g
SS710293	752620	2084725	0.083	0.17	Nitrite	11	1	NA	102000	mg/kg
SS710293	752620	2084725	0.083	0.17	Barium	163	20	141.26	26400	mg/kg
SS710393	752888	2084803	0.083	0.17	Americium-241	0.038	0	0.023	76	pCi/g
SS710393	752888	2084803	0.083	0.17	Beryllium	1.1	0.21	0.966	921	mg/kg
SS710393	752888	2084803	0.083	0.17	Nitrite	5	1	NA	102000	mg/kg
SS710393	752888	2084803	0.083	0.17	Barium	166	20	141.26	26400	mg/kg
SS710593	753025	2084745	0.083	0.17	Barium	145	20	141.26	26400	mg/kg

Table 1

Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS710593	753025	2084745	0.083	0.17	Nitrite	6	1	NA	102000	mg/kg
SS710693	753084	2084789	0.083	0.17	Nitrite	41	1	NA	102000	mg/kg
SS710793	753182	2084798	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS710793	753182	2084798	0.083	0.17	Barium	222	20	141.26	26400	mg/kg
SS710893	753279	2084788	0.083	0.17	Beryllium	1	0.073	0.966	921	mg/kg
SS710893	753279	2084788	0.083	0.17	Zinc	75.4	4	73.76	307000	mg/kg
SS710893	753279	2084788	0.083	0.17	Barium	171	20	141.26	26400	mg/kg
SS710893	753279	2084788	0.083	0.17	Nitrite	45	1	NA	102000	mg/kg
SS710993	753153	2084894	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS710993	753153	2084894	0.083	0.17	Barium	204	20	141.26	26400	mg/kg
SS711093	753057	2084867	0.083	0.17	Americium-241	0.036	0	0.023	76	pCi/g
SS711093	753057	2084867	0.083	0.17	Plutonium-239/240	0.099	0	0.066	50	pCi/g
SS711093	753057	2084867	0.083	0.17	Copper	19.6	1	18.06	40900	mg/kg
SS711093	753057	2084867	0.083	0.17	Zinc	87.5	4	73.76	307000	mg/kg
SS711093	753057	2084867	0.083	0.17	Nitrite	17	1	NA	102000	mg/kg
SS711093	753057	2084867	0.083	0.17	Barium	196	20	141.26	26400	mg/kg
SS711293	752974	2084968	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS711393	752961	2084849	0.083	0.17	Beryllium	1.2	0.077	0.966	921	mg/kg
SS711393	752961	2084849	0.083	0.17	Cobalt	11.5	10	10.91	1550	mg/kg
SS711393	752961	2084849	0.083	0.17	Nickel	17	5	14.91	20400	mg/kg
SS711393	752961	2084849	0.083	0.17	Nitrite	22	1	NA	102000	mg/kg
SS711393	752961	2084849	0.083	0.17	Manganese	405	3	365.08	3480	mg/kg
SS711393	752961	2084849	0.083	0.17	Iron	26800	1.1	18037	307000	mg/kg
SS711493	752864	2084865	0.083	0.17	Plutonium-239/240	0.083	0.006	0.066	50	pCi/g
SS711493	752864	2084865	0.083	0.17	Beryllium	1	0.21	0.966	921	mg/kg
SS711493	752864	2084865	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS711493	752864	2084865	0.083	0.17	Barium	144	20	141.26	26400	mg/kg
SS711693	752694	2084860	0.083	0.17	Americium-241	0.030	0	0.023	76	pCi/g

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS711693	752694	2084860	0.083	0.17	Plutonium-239/240	0.090	0.025	0.066	50	pCi/g
SS711693	752694	2084860	0.083	0.17	Manganese	370	3	365.08	3480	mg/kg
SS711693	752694	2084860	0.083	0.17	Nitrite	8	1	NA	102000	mg/kg
SS711793	752614	2084808	0.083	0.17	Beryllium	0.98	0.24	0.966	921	mg/kg
SS711793	752614	2084808	0.083	0.17	Barium	153	20	141.26	26400	mg/kg
SS711793	752614	2084808	0.083	0.17	Nitrite	12	1	NA	102000	mg/kg
SS711893	752575	2084902	0.083	0.17	Americium-241	0.048	0	0.023	76	pCi/g
SS711893	752575	2084902	0.083	0.17	Lead	55	2.9	54.62	1000	mg/kg
SS711893	752575	2084902	0.083	0.17	Nitrite	19	1	NA	102000	mg/kg
SS711993	752624	2085027	0.083	0.17	Americium-241	0.051	0	0.023	76	pCi/g
SS711993	752624	2085027	0.083	0.17	Plutonium-239/240	0.268	0	0.066	50	pCi/g
SS711993	752624	2085027	0.083	0.17	Copper	20.9	1	18.06	40900	mg/kg
SS711993	752624	2085027	0.083	0.17	Nitrite	10	1	NA	102000	mg/kg
SS711993	752624	2085027	0.083	0.17	Zinc	87.9	4	73.76	307000	mg/kg
SS712093	752770	2084911	0.083	0.17	Americium-241	0.029	0	0.023	76	pCi/g
SS712093	752770	2084911	0.083	0.17	Plutonium-239/240	0.099	0	0.066	50	pCi/g
SS712093	752770	2084911	0.083	0.17	Nickel	17.1	5	14.91	20400	mg/kg
SS712093	752770	2084911	0.083	0.17	Copper	21.9	1	18.06	40900	mg/kg
SS712093	752770	2084911	0.083	0.17	Cobalt	16.2	10	10.91	1550	mg/kg
SS712093	752770	2084911	0.083	0.17	Nitrite	11	1	NA	102000	mg/kg
SS712093	752770	2084911	0.083	0.17	Zinc	86.8	4	73.76	307000	mg/kg
SS712193	752764	2084992	0.083	0.17	Americium-241	0.045	0	0.023	76	pCi/g
SS712193	752764	2084992	0.083	0.17	Plutonium-239/240	0.097	0.013	0.066	50	pCi/g
SS712193	752764	2084992	0.083	0.17	Nitrite	10	1	NA	102000	mg/kg
SS712293	752857	2085033	0.083	0.17	Nitrite	4	1	NA	102000	mg/kg
SS712393	752983	2085062	0.083	0.17	Americium-241	0.049	0	0.023	76	pCi/g
SS712393	752983	2085062	0.083	0.17	Beryllium	1	0.2	0.966	921	mg/kg
SS712393	752983	2085062	0.083	0.17	Plutonium-239/240	0.149	0.011	0.066	50	pCi/g

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS712393	752983	2085062	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS712393	752983	2085062	0.083	0.17	Barium	150	20	141.26	26400	mg/kg
SS712693	752251	2082576	0.083	0.17	Americium-241	0.062	0	0.023	76	pCi/g
SS712693	752251	2082576	0.083	0.17	Plutonium-239/240	0.162		0.066	50	pCi/g
SS712693	752251	2082576	0.083	0.17	Nitrite	6	1	NA	102000	mg/kg
SS712793	752235	2082598	0.083	0.17	Americium-241	0.024	0	0.023	76	pCi/g
SS712793	752235	2082598	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS712893	752221	2082617	0.083	0.17	Americium-241	0.343	0.004	0.023	76	pCi/g
SS712893	752221	2082617	0.083	0.17	Plutonium-239/240	1.242	0.017	0.066	50	pCi/g
SS712893	752221	2082617	0.083	0.17	Nickel	16.2	5	14.91	20400	mg/kg
SS712893	752221	2082617	0.083	0.17	Cobalt	27.1	10	10.91	1550	mg/kg
SS712893	752221	2082617	0.083	0.17	Manganese	650	3	365.08	3480	mg/kg
SS712993	752206	2082638	0.083	0.17	Americium-241	0.210	0	0.023	76	pCi/g
SS712993	752206	2082638	0.083	0.17	Plutonium-239/240	0.521		0.066	50	pCi/g
SS712993	752206	2082638	0.083	0.17	Copper	18.7	1	18.06	40900	mg/kg
SS712993	752206	2082638	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS713093	752190	2082658	0.083	0.17	Americium-241	0.085	0	0.023	76	pCi/g
SS713093	752190	2082658	0.083	0.17	Plutonium-239/240	0.196	0.013	0.066	50	pCi/g
SS713093	752190	2082658	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS713193	752175	2082678	0.083	0.17	Americium-241	0.038	0	0.023	76	pCi/g
SS713193	752175	2082678	0.083	0.17	Plutonium-239/240	0.105		0.066	50	pCi/g
SS713193	752175	2082678	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS713293	752197	2082692	0.083	0.17	Americium-241	0.031	0	0.023	76	pCi/g
SS713293	752197	2082692	0.083	0.17	Plutonium-239/240	0.086		0.066	50	pCi/g
SS713293	752197	2082692	0.083	0.17	Antimony	5.5	4	0.47	409	mg/kg
SS713393	752211	2082671	0.083	0.17	Americium-241	0.028	0	0.023	76	pCi/g
SS713393	752211	2082671	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS713393	752211	2082671	0.083	0.17	Chromium	21.2	2	16.99	268	mg/kg

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS713493	752227	2082652	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS713593	752241	2082629	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS713693	752255	2082610	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS713693	752255	2082610	0.083	0.17	Antimony	6	4	0.47	409	mg/kg
SS713793	752271	2082589	0.083	0.17	Nickel	17.2	5	14.91	20400	mg/kg
SS713793	752271	2082589	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS713793	752271	2082589	0.083	0.17	Manganese	406	3	365.08	3480	mg/kg
SS713793	752271	2082589	0.083	0.17	Barium	184	20	141.26	26400	mg/kg
SS713893	752287	2082568	0.083	0.17	Americium-241	0.034	0	0.023	76	pCi/g
SS713893	752287	2082568	0.083	0.17	Plutonium-239/240	0.239		0.066	50	pCi/g
SS713893	752287	2082568	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS713993	752307	2082583	0.083	0.17	Americium-241	0.026	0	0.023	76	pCi/g
SS713993	752307	2082583	0.083	0.17	Nitrite	6	1	NA	102000	mg/kg
SS714093	752292	2082604	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS714293	752262	2082644	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS714293	752262	2082644	0.083	0.17	Antimony	6.3	4	0.47	409	mg/kg
SS714293	752262	2082644	0.083	0.17	Barium	156	20	141.26	26400	mg/kg
SS714293	752262	2082644	0.083	0.17	Vanadium	66.2	8	45.59	7150	mg/kg
SS714393	752247	2082665	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS715093	752297	2082639	0.083	0.17	Nitrite	1	1	NA	102000	mg/kg
SS715293	752328	2082599	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS715393	752347	2082613	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS715393	752347	2082613	0.083	0.17	Copper	23	1	18.06	40900	mg/kg
SS715493	752332	2082633	0.083	0.17	Americium-241	0.027	0	0.023	76	pCi/g
SS715493	752332	2082633	0.083	0.17	Nitrite	3	1	NA	102000	mg/kg
SS715493	752332	2082633	0.083	0.17	Barium	146	20	141.26	26400	mg/kg
SS715493	752332	2082633	0.083	0.17	Antimony	10.1	4	0.47	409	mg/kg
SS715593	752316	2082654	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS715593	752316	2082654	0.083	0.17	Antimony	10.7	4	0.47	409	mg/kg
SS715693	752299	2082670	0.083	0.17	Barium	161	20	141.26	26400	mg/kg
SS715693	752299	2082670	0.083	0.17	Manganese	471	3	365.08	3480	mg/kg
SS715793	752289	2082692	0.083	0.17	Antimony	11.3	4	0.47	409	mg/kg
SS715893	752273	2082713	0.083	0.17	Copper	27.9	1	18.06	40900	mg/kg
SS715993	752258	2082733	0.083	0.17	Antimony	9.7	4	0.47	409	mg/kg
SS715993	752258	2082733	0.083	0.17	Iron	20400	0.99	18037	307000	mg/kg
SS716193	752295	2082727	0.083	0.17	Copper	18.8	1	18.06	40900	mg/kg
SS716293	752311	2082706	0.083	0.17	Copper	20.2	1	18.06	40900	mg/kg
SS716293	752311	2082706	0.083	0.17	Antimony	5.5	4	0.47	409	mg/kg
SS716593	752353	2082649	0.083	0.17	Copper	19.9	1	18.06	40900	mg/kg
SS716593	752353	2082649	0.083	0.17	Barium	179	20	141.26	26400	mg/kg
SS716593	752353	2082649	0.083	0.17	Manganese	584	3	365.08	3480	mg/kg
SS716693	752367	2082628	0.083	0.17	Copper	34.9	1	18.06	40900	mg/kg
SS716793	752390	2082644	0.083	0.17	Copper	25	1	18.06	40900	mg/kg
SS716893	752375	2082663	0.083	0.17	Mercury	0.14	0.12	0.134	25200	mg/kg
SS716893	752375	2082663	0.083	0.17	Copper	20.8	1	18.06	40900	mg/kg
SS717093	752347	2082701	0.083	0.17	Copper	19.1	1	18.06	40900	mg/kg
SS717193	752333	2082719	0.083	0.17	Nickel	15.2	5	14.91	20400	mg/kg
SS717193	752333	2082719	0.083	0.17	Copper	22.1	1	18.06	40900	mg/kg
SS717193	752333	2082719	0.083	0.17	Iron	18800	1	18037	307000	mg/kg
SS717293	752315	2082741	0.083	0.17	Nitrite	2	1	NA	102000	mg/kg
SS717293	752315	2082741	0.083	0.17	Copper	21.8	1	18.06	40900	mg/kg
SS717293	752315	2082741	0.083	0.17	Iron	18700	1.1	18037	307000	mg/kg
SS717393	752300	2082761	0.083	0.17	Nickel	16.2	5	14.91	20400	mg/kg
SS717393	752300	2082761	0.083	0.17	Copper	22.1	1	18.06	40900	mg/kg
SS717493	752682	2082765	0	0.17	Antimony	4.4	4	0.47	409	mg/kg
SS717593	752543	2082823	0	0.17	Americium-241	0.043	0.002	0.023	76	pCi/g

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS717593	752543	2082823	0	0.17	Beryllium	1	0.19	0.966	921	mg/kg
SS717593	752543	2082823	0	0.17	Plutonium-239/240	0.234	0.01	0.066	50	pCi/g
SS717593	752543	2082823	0	0.17	Nickel	15.1	5	14.91	20400	mg/kg
SS717693	752403	2082879	0	0.17	Plutonium-239/240	0.088	0.008	0.066	50	pCi/g
SS717693	752403	2082879	0	0.17	Americium-241	0.046	0.002	0.023	76	pCi/g
SS717693	752403	2082879	0	0.17	Benzo(k)fluoranthene	590	350	NA	349000	ug/kg
SS717693	752403	2082879	0	0.17	Fluorene	680	660	NA	40800000	ug/kg
SS717693	752403	2082879	0	0.17	Naphthalene	690	660	NA	3090000	ug/kg
SS717693	752403	2082879	0	0.17	Acenaphthene	800	660	NA	40800000	ug/kg
SS717693	752403	2082879	0	0.17	Benzo(a)pyrene	920	660	NA	3490	ug/kg
SS717693	752403	2082879	0	0.17	Chrysene	950	660	NA	3490000	ug/kg
SS717693	752403	2082879	0	0.17	Benzo(a)anthracene	990	660	NA	34900	ug/kg
SS717693	752403	2082879	0	0.17	Benzo(b)fluoranthene	1400	660	NA	34900	ug/kg
SS717693	752403	2082879	0	0.17	Pyrene	2600	660	NA	22100000	ug/kg
SS717693	752403	2082879	0	0.17	Fluoranthene	2800	660	NA	27200000	ug/kg
SS717893	752762	2082961	0	0.17	Tin	6.1	3.4	2.9	613000	mg/kg
SS717993	752622	2083018	0	0.17	Nickel	16.7	5	14.91	20400	mg/kg
SS717993	752622	2083018	0	0.17	Antimony	4.4	4	0.47	409	mg/kg
SS718193	752353	2083131	0	0.17	Antimony	7.2	4	0.47	409	mg/kg
SS718193	752353	2083131	0	0.17	Barium	184	20	141.26	26400	mg/kg
SS718293	752843	2083157	0	0.17	Nickel	15.1	5	14.91	20400	mg/kg
SS718393	752704	2083214	0	0.17	Americium-241	0.025	0	0.023	76	pCi/g
SS718393	752704	2083214	0	0.17	Beryllium	0.99	0.19	0.966	921	mg/kg
SS718393	752704	2083214	0	0.17	Nickel	15.4	5	14.91	20400	mg/kg
SS718393	752704	2083214	0	0.17	Fluoranthene	830	660	NA	27200000	ug/kg
SS718393	752704	2083214	0	0.17	Pyrene	840	660	NA	22100000	ug/kg
SS718493	752563	2083271	0	0.17	Antimony	4.7	4	0.47	409	mg/kg
SS718593	752423	2083328	0	0.17	Americium-241	0.027	0.005	0.023	76	pCi/g

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS718593	752423	2083328	0	0.17	Antimony	5.8	4	0.47	409	mg/kg
SS718593	752423	2083328	0	0.17	Copper	81.5	1	18.06	40900	mg/kg
SS718693	752925	2083353	0	0.17	Beryllium	1.1	0.19	0.966	921	mg/kg
SS718693	752925	2083353	0	0.17	Strontium	50.3	40	48.94	613000	mg/kg
SS718693	752925	2083353	0	0.17	Tin	4.3	3.5	2.9	613000	mg/kg
SS718693	752925	2083353	0	0.17	Benzo(b)fluoranthene	710	660	NA	34900	ug/kg
SS718693	752925	2083353	0	0.17	Fluoranthene	1100	660	NA	27200000	ug/kg
SS718693	752925	2083353	0	0.17	Pyrene	1200	660	NA	22100000	ug/kg
SS718793	752785	2083411	0	0.17	Plutonium-239/240	0.069	0	0.066	50	pCi/g
SS718793	752785	2083411	0	0.17	Beryllium	1	0.2	0.966	921	mg/kg
SS718793	752785	2083411	0	0.17	Copper	43.4	1	18.06	40900	mg/kg
SS718793	752785	2083411	0	0.17	Fluoranthene	850	660	NA	27200000	ug/kg
SS718793	752785	2083411	0	0.17	Pyrene	870	660	NA	22100000	ug/kg
SS718893	752646	2083467	0	0.17	Beryllium	1	0.2	0.966	921	mg/kg
SS718893	752646	2083467	0	0.17	Nickel	17	5	14.91	20400	mg/kg
SS718993	752506	2083524	0	0.17	Plutonium-239/240	0.073	0.008	0.066	50	pCi/g
SS718993	752506	2083524	0	0.17	Chromium	22.1	2	16.99	268	mg/kg
SS718993	752506	2083524	0	0.17	Iron	18600	1.7	18037	307000	mg/kg
SS718993	752506	2083524	0	0.17	Fluoranthene	810	660	NA	27200000	ug/kg
SS718993	752506	2083524	0	0.17	Pyrene	860	660	NA	22100000	ug/kg
SS719093	753006	2083548	0	0.17	Americium-241	0.026	0.003	0.023	76	pCi/g
SS719093	753006	2083548	0	0.17	Plutonium-239/240	0.167	0.009	0.066	50	pCi/g
SS719093	753006	2083548	0	0.17	Strontium	57.4	40	48.94	613000	mg/kg
SS719093	753006	2083548	0	0.17	Manganese	400	3	365.08	3480	mg/kg
SS719293	752726	2083663	0	0.17	Nickel	15	5	14.91	20400	mg/kg
SS719293	752726	2083663	0	0.17	Antimony	4.9	4	0.47	409	mg/kg
SS719393	752586	2083720	0	0.17	Plutonium-239/240	0.073	0.005	0.066	50	pCi/g
SS719393	752586	2083720	0	0.17	Nickel	15.3	5	14.91	20400	mg/kg

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS719493	753157	2083874	0	0.17	Benzo(k)fluoranthene	560	350	NA	349000	ug/kg
SS719493	753157	2083874	0	0.17	Benzo(a)pyrene	1000	660	NA	3490	ug/kg
SS719493	753157	2083874	0	0.17	Benzo(a)anthracene	1100	660	NA	34900	ug/kg
SS719493	753157	2083874	0	0.17	Chrysene	1100	660	NA	3490000	ug/kg
SS719493	753157	2083874	0	0.17	Benzo(b)fluoranthene	1400	660	NA	34900	ug/kg
SS719493	753157	2083874	0	0.17	Pyrene	2300	660	NA	22100000	ug/kg
SS719493	753157	2083874	0	0.17	Fluoranthene	2400	660	NA	27200000	ug/kg
SS719593	752596	2084071	0	0.17	Strontium	55.4	40	48.94	613000	mg/kg
SS719593	752596	2084071	0	0.17	Barium	186	20	141.26	26400	mg/kg
SS719593	752596	2084071	0	0.17	Pyrene	900	660	NA	22100000	ug/kg
SS719593	752596	2084071	0	0.17	Fluoranthene	980	660	NA	27200000	ug/kg
SS719693	753110	2084066	0	0.17	Beryllium	1	0.19	0.966	921	mg/kg
SS719693	753110	2084066	0	0.17	Strontium	49.8	40	48.94	613000	mg/kg
SS719693	753110	2084066	0	0.17	Nitrite	2	1	NA	102000	mg/kg
SS719693	753110	2084066	0	0.17	Tin	9.1	5.1	2.9	613000	mg/kg
SS719693	753110	2084066	0	0.17	Barium	187	20	141.26	26400	mg/kg
SS719793	753100	2084015	0	0.17	Nickel	15	5	14.91	20400	mg/kg
SS719793	753100	2084015	0	0.17	Strontium	49.1	40	48.94	613000	mg/kg
SS719793	753100	2084015	0	0.17	Nitrite	1	1	NA	102000	mg/kg
SS719893	753096	2083964	0	0.17	Nitrite	1	1	NA	102000	mg/kg
SS719893	753096	2083964	0	0.17	Tin	14.5	5.1	2.9	613000	mg/kg
SS719893	753096	2083964	0	0.17	Barium	226	20	141.26	26400	mg/kg
SS719993	753092	2083914	0	0.17	Copper	18.5	1	18.06	40900	mg/kg
SS719993	753092	2083914	0	0.17	Nitrite	2	1	NA	102000	mg/kg
SS719993	753092	2083914	0	0.17	Tin	5.6	4.4	2.9	613000	mg/kg
SS719993	753092	2083914	0	0.17	Barium	175	20	141.26	26400	mg/kg
SS720093	753142	2083908	0	0.17	Nitrite	2	1	NA	102000	mg/kg
SS720093	753142	2083908	0	0.17	Tin	13.4	4.5	2.9	613000	mg/kg

Table 1
Surface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS720193	753146	2083960	0	0.17	Nitrite	2	1	NA	102000	mg/kg
SS720193	753146	2083960	0	0.17	Tin	8.5	4.7	2.9	613000	mg/kg
SS720193	753146	2083960	0	0.17	Strontium	80.6	40	48.94	613000	mg/kg
SS720293	753149	2084012	0	0.17	Vanadium	45.6	8	45.59	7150	mg/kg
SS720293	753149	2084012	0	0.17	Beryllium	1	0.16	0.966	921	mg/kg
SS720293	753149	2084012	0	0.17	Strontium	50.7	40	48.94	613000	mg/kg
SS720293	753149	2084012	0	0.17	Nitrite	2	1	NA	102000	mg/kg
SS720293	753149	2084012	0	0.17	Tin	10.7	4.2	2.9	613000	mg/kg
SS720293	753149	2084012	0	0.17	Iron	19300	1.4	18037	307000	mg/kg
SS720393	753160	2084065	0	0.17	Barium	142	20	141.26	26400	mg/kg
SS720393	753160	2084065	0	0.17	Nitrite	1	1	NA	102000	mg/kg
SS720393	753160	2084065	0	0.17	Tin	7	4.4	2.9	613000	mg/kg
SS720493	753164	2084099	0	0.17	Nitrite	2	1	NA	102000	mg/kg
SS720493	753164	2084099	0	0.17	Tin	6.4	5.1	2.9	613000	mg/kg
SS720493	753164	2084099	0	0.17	Strontium	54.9	40	48.94	613000	mg/kg
SS720493	753164	2084099	0	0.17	Barium	270	20	141.26	26400	mg/kg

Table 2
Surface Soil Summary by Analyte Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Analyte	Total Number Samples Analyzed	Detection Frequency	Average Concentration	Maximum Concentration	Standard Deviation	Detection Limit	Background Mean Plus 2SD	Wildlife Refuge Worker Action Level	Unit
Acenaphthene	19	0.053	800	800	-	660	-	40800000	ug/kg
Aluminum	217	0.023	19480	22800	1905.781	3	16902	228000	mg/kg
Americium-241	197	0.299	0.074	1.076	0.156	0.003	0.023	76	pCi/g
Antimony	216	0.157	21.088	348	58.114	4	0.47	409	mg/kg
Barium	217	0.608	216.644	1120	103.738	20	141.26	26400	mg/kg
Benzo(a)anthracene	19	0.105	1045	1100	77.782	660	NA	34900	ug/kg
Benzo(a)pyrene	19	0.105	960	1000	56.569	660	NA	3490	ug/kg
Benzo(b)fluoranthene	19	0.158	1170	1400	398.372	660	NA	34900	ug/kg
Benzo(k)fluoranthene	19	0.105	575	590	21.213	350	NA	349000	ug/kg
Beryllium	217	0.097	1.080	1.4	0.104	0.285	0.966	921	mg/kg
Chromium	217	0.051	20.109	23.3	2.247	2	16.99	268	mg/kg
Chrysene	19	0.105	1025	1100	106.066	660	NA	3490000	ug/kg
Cobalt	217	0.051	13.891	27.1	4.753	10	10.91	1550	mg/kg
Copper	217	0.134	45.486	640	114.993	1	18.06	40900	mg/kg
Fluoranthene	19	0.368	1395.714	2800	836.836	660	NA	27200000	ug/kg
Fluorene	19	0.053	680	680	-	660	NA	40800000	ug/kg
Iron	217	0.092	22305	59600	9111.212	6.783	18037	307000	mg/kg
Lead	75	0.120	80.633	167	38.627	5.044	54.62	1000	mg/kg
Manganese	217	0.092	564.85	1370	288.342	3	365.08	3480	mg/kg
Mercury	215	0.014	0.15	0.16	0.01	0.107	0.134	25200	mg/kg
Naphthalene	19	0.053	690	690	-	660	NA	3090000	ug/kg
Nickel	217	0.147	16.756	23.8	1.89	5	14.91	20400	mg/kg
Nitrite	178	0.736	5.168	45	6.39	0.954	NA	102000	mg/kg
Plutonium-239/240	190	0.279	0.170	1.242	0.18	0.009	0.066	50	pCi/g
Pyrene	19	0.368	1367.143	2600	754.82	660	NA	22100000	ug/kg
Strontium	60	0.350	57.429	80.6	8.47	40	48.94	613000	mg/kg
Tin	60	0.217	21.677	72.3	25.27	12.646	2.9	613000	mg/kg
Toluene	2	1.000	260	290	42.43	5	NA	31300000	ug/kg

Table 2
Surface Soil Summary by Analyte Greater Than Background Means Plus Two Standard Deviations or Method Detection Limits

Analyte	Total Number Samples Analyzed	Detection Frequency	Average Concentration	Maximum Concentration	Standard Deviation	Detection Limit	Background Mean Plus 2SD	Wildlife Refuge Worker Action Level	Unit
Vanadium	217	0.037	58.788	86.2	14.32	8	45.59	7150	mg/kg
Zinc	217	0.083	89.306	119	11.95	4	73.76	307000	mg/kg

Table 3
Surface Soil Method Summary by Location

Location Code	Metals	Radionuclides	SVOCs	VOAs	PCBs	Inorganics
68992				33		
69192				33		
SS120594	22	5				1
SS120694	22	5				1
SS120794	22	5				1
SS120894	22	5				1
SS120994	22	5				1
SS121094	22	5				1
SS121194	22	4				1
SS121294	22	5				1
SS121394	22	5				1
SS121494	21	5				1
SS121594	22	5				1
SS121694	22	5				1
SS604092	21					
SS604192	21					
SS604392	20					
SS604492	21	5				
SS604592	20					
SS604692	20	5				
SS604792	20	5				
SS604892	21	5				
SS604992	21	5				
SS605092	21	5				
SS605192	20	5				
SS605292	20	2				
SS605392	22	4				
SS605492	22	4				
SS605592	22	4				
SS605692	22	5				
SS605792	22	5				
SS605892	22	5				
SS605992	22	5				
SS606092	20	5				
SS700093	18	5				1
SS700193	17	5				1
SS700293	18	5				1
SS700393	17	5				1
SS700493	18	5				1
SS700593	18	5				1
SS700693	17	5				1
SS700793	17	5				1
SS700893	17	5				1
SS700993	17	4				1
SS701193	17	5				1
SS701293	17	5				1
SS701393	17	5				1

Table 3
Surface Soil Method Summary by Location

Location Code	Metals	Radionuclides	SVOCs	VOAs	PCBs	Inorganics
SS701493	17	5				1
SS701593	17	5				1
SS701693	17	5				1
SS701793	17	5				1
SS701893	17	5				1
SS701993	17	4				1
SS702093	17	5				1
SS702193	17	5				1
SS702293	17	5				1
SS702393	17	5				1
SS702493	17	5				1
SS702593	17	5				1
SS702693	17	4				1
SS702793	17	5				1
SS702893	17	5				1
SS702993	17	5				1
SS703093	17	5				1
SS703193	17	5				1
SS703293	17	4				1
SS703393	17	5				1
SS703493	17	5				1
SS703593	17	5				1
SS703693	17	5				1
SS703793	17	5				1
SS703893	17	5				1
SS703993	17	5				1
SS704093	16	5				1
SS704193	16	5				1
SS704293	17	5				1
SS704393	17	5				1
SS704493	18	5				1
SS704593	17	5				1
SS704693	17	2				1
SS704793	17	5				1
SS704893	16	5				1
SS704993	16	5				1
SS705093	16	4				1
SS705193	17	4				1
SS705293	15	4				1
SS705393	16	4				1
SS705493	17	4				1
SS705593	16					1
SS705693	16	4				1
SS705793	16	4				1
SS705893	17	4				1
SS705993	17	4				1
SS706093	17	4				1

Table 3
Surface Soil Method Summary by Location

Location Code	Metals	Radionuclides	SVOCs	VOAs	PCBs	Inorganics
SS706193	17	4				1
SS706293	16	4				1
SS706393	17	4				1
SS706493	16	4				1
SS706593	17	5				1
SS706793	17	5				1
SS706993	17	4				1
SS707093	17	5				1
SS707193	17	5				1
SS707293	17	5				1
SS707393	17	5				1
SS707493	17	4				1
SS707593	17	4				1
SS707693	17	4				1
SS707793	17	4				1
SS707893	18	5				1
SS707993	17	5				1
SS708093	17	4				1
SS708193	17	4				1
SS708293	12	4				1
SS708393	17	4				1
SS708493	17	4				1
SS708593	17	5				1
SS708693	17	5				1
SS708793	17	5				1
SS708893	18	5				1
SS709093	17	5				1
SS709193	17	5				1
SS709293	17	5				1
SS709393	17	5				1
SS709493	17	5				1
SS709593	18	5			7	1
SS709693	18	5			7	1
SS709793	18	5				1
SS709893	18	5				1
SS709993	18	5				1
SS710093	18	5				1
SS710193	17	5				1
SS710293	18	5				1
SS710393	18	5				1
SS710593	17	5				1
SS710693	17	5				1
SS710793	17	5				1
SS710893	17	5				1
SS710993	17	5				1
SS711093	17	5				1
SS711293	18	4				1

Table 3
Surface Soil Method Summary by Location

Location Code	Metals	Radionuclides	SVOCs	VOAs	PCBs	Inorganics
SS711393	17	5				1
SS711493	18	5				1
SS711693	18	5				1
SS711793	18	4				1
SS711893	18	4				1
SS711993	18	5				1
SS712093	18	5				1
SS712193	18	5				1
SS712293	18	5				1
SS712393	18	5				1
SS712693	17	5			7	1
SS712793	16	5			7	1
SS712893	17	5			7	1
SS712993	17	5			7	1
SS713093	16	5			7	1
SS713193	17	5			7	1
SS713293	17	5			7	1
SS713393	17	5			7	1
SS713493	17	5			7	1
SS713593	17	5			7	1
SS713693	17	4			7	1
SS713793	17	4			7	1
SS713893	17	5			7	1
SS713993	16	5			7	1
SS714093	16	5			7	1
SS714193	17	5			7	1
SS714293	17	5			7	1
SS714393	17	5			7	1
SS715093	18	5			7	1
SS715293	18	5			7	1
SS715393	18	5			7	1
SS715493	18	5			7	1
SS715593	18	5			7	1
SS715693	18	5			7	1
SS715793	18	5			7	1
SS715893	18	5			7	1
SS715993	18	5			7	1
SS716093	18	5			7	1
SS716193	18	5			7	1
SS716293	18	5			7	1
SS716493	18	5			7	1
SS716593	18	5			7	1
SS716693	18	5			7	1
SS716793	18	5			7	1
SS716893	18	5			7	1
SS716993	18	5			7	1
SS717093	18	5			7	1

Table 3
Surface Soil Method Summary by Location

Location Code	Metals	Radionuclides	SVOCs	VOAs	PCBs	Inorganics
SS717193	18	5			7	1
SS717293	18	5			7	1
SS717393	18	5			7	1
SS717493	20	5	54			
SS717593	22	5	54			
SS717693	22	5	53			
SS717893	21	5	53			
SS717993	20	5	53			
SS718193	21	5	53			
SS718293	20	5	54			
SS718393	20	5	54			
SS718493	21	5	54			
SS718593	21	5	53			
SS718693	21	5	54			
SS718793	21	5	54			
SS718893	21	5	53			
SS718993	21	5	53			
SS719093	21	5	53			
SS719293	22	5	53			
SS719393	21	5	53			
SS719493	21	5	54			
SS719593	22	5	54			
SS719693	21	5				1
SS719793	20	5				1
SS719893	21	5				1
SS719993	21	5				1
SS720093	22	5				1
SS720193	22	5				1
SS720293	22	5				1
SS720393	22	5				1
SS720493	21	5				1

Table 4
Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
00393	753173.5	2083768	0.5	0.7	Toluene	370	5	NA	31300000	ug/kg
00393	753173.5	2083768	2.2	2.6	Toluene	43	5	NA	31300000	ug/kg
00393	753173.5	2083768	5.8	6	Toluene	15	5	NA	31300000	ug/kg
00393	753173.5	2083768	8.8	9	Toluene	18	5	NA	31300000	ug/kg
00393	753173.5	2083768	6.2	12.2	Manganese	915	3	901.62	3480	mg/kg
00493	752532.6	2083930	0.35	0.55	Toluene	1200	5	NA	31300000	ug/kg
00493	752532.6	2083930	0.35	0.55	Xylene	5	5	NA	2040000	ug/kg
00493	752532.6	2083930	1.6	1.8	Fluoranthene	960	660	NA	27200000	ug/kg
00493	752532.6	2083930	1.6	1.8	Pyrene	1600	660	NA	22100000	ug/kg
00493	752532.6	2083930	1.6	1.8	Toluene	68	5	NA	31300000	ug/kg
00493	752532.6	2083930	2.1	2.3	Toluene	620	5	NA	31300000	ug/kg
00493	752532.6	2083930	7.4	7.6	Toluene	400	5	NA	31300000	ug/kg
00493	752532.6	2083930	7.4	7.6	Vanadium	119	8	88.49	7150	mg/kg
00493	752532.6	2083930	9.8	10	Toluene	43	5	NA	31300000	ug/kg
00493	752532.6	2083930	11.8	12	Toluene	170	5	NA	31300000	ug/kg
66892	752425	2083922	1.2	1.4	Toluene	31	5	NA	31300000	ug/kg
66892	752425	2083922	2.2	2.4	Toluene	46	5	NA	31300000	ug/kg
66892	752425	2083922	0	6.2	Plutonium-239/240	0.026	0.005	0.02	50	pCi/g
66892	752425	2083922	6	6.2	Toluene	5	5	NA	31300000	ug/kg
66892	752425	2083922	10.1	10.3	Toluene	6	5	NA	31300000	ug/kg
66892	752425	2083922	10.1	10.3	Trichloroethene	9	5	NA	19600	ug/kg
66892	752425	2083922	6.2	12.3	Barium	414	20	289.38	26400	mg/kg
66892	752425	2083922	6.2	12.3	Chromium	130	2	68.27	268	mg/kg
66892	752425	2083922	6.2	12.3	Copper	52.1	1	38.21	40900	mg/kg
66892	752425	2083922	6.2	12.3	Molybdenum	27.9	8	25.61	5110	mg/kg
66892	752425	2083922	12.1	12.3	Toluene	10	5	NA	31300000	ug/kg
66892	752425	2083922	12.1	12.3	Trichloroethene	6	5	NA	19600	ug/kg
67092	752434	2083971	8.4	8.6	Trichloroethene	12	5	NA	19600	ug/kg
67192	752439	2083998	7.4	7.6	Trichloroethene	21	5	NA	19600	ug/kg

Table 4
Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
67192	752439	2083998	9.2	9.4	Toluene	8	5	NA	31300000	ug/kg
67192	752439	2083998	6	12	Barium	551	20	289.38	26400	mg/kg
67192	752439	2083998	12	12.2	Toluene	5	5	NA	31300000	ug/kg
67292	752443	2084020	7.1	7.3	Toluene	5	5	NA	31300000	ug/kg
67292	752443	2084020	9.5	9.7	Toluene	5	5	NA	31300000	ug/kg
67292	752443	2084020	11.8	12	Toluene	5	5	NA	31300000	ug/kg
67392	752448	2084046	1	1.2	Toluene	6	5	NA	31300000	ug/kg
67392	752448	2084046	7.4	7.6	Toluene	5	5	NA	31300000	ug/kg
67392	752448	2084046	9.2	9.5	Toluene	5	5	NA	31300000	ug/kg
67392	752448	2084046	11.3	11.5	Toluene	7	5	NA	31300000	ug/kg
67492	752451	2084068	0.7	0.9	Toluene	10	5	NA	31300000	ug/kg
67492	752451	2084068	7.6	7.8	Toluene	5	5	NA	31300000	ug/kg
67592	752201	2083853	1.4	1.6	2-Butanone	940	100	NA	192000000	ug/kg
67592	752201	2083853	3.1	3.3	2-Butanone	670	100	NA	192000000	ug/kg
67592	752201	2083853	4.4	4.6	2-Butanone	1600	100	NA	192000000	ug/kg
67592	752201	2083853	7.8	8	2-Butanone	680	100	NA	192000000	ug/kg
67592	752201	2083853	10.1	10.3	2-Butanone	460	100	NA	192000000	ug/kg
67592	752201	2083853	12	12.2	2-Butanone	510	100	NA	192000000	ug/kg
67592	752201	2083853	5.8	12.2	Barium	332	20	289.38	26400	mg/kg
67592	752201	2083853	5.8	12.2	Manganese	907	3	901.62	3480	mg/kg
67692	752207	2083876	1.3	1.5	2-Butanone	510	100	NA	192000000	ug/kg
67692	752207	2083876	2.4	2.6	2-Butanone	930	100	NA	192000000	ug/kg
67692	752207	2083876	2.4	2.6	Toluene	6	5	NA	31300000	ug/kg
67692	752207	2083876	5.6	5.8	2-Butanone	250	100	NA	192000000	ug/kg
67792	752212	2083904	1.4	1.6	Toluene	23	5	NA	31300000	ug/kg
67792	752212	2083904	2.9	3.1	Toluene	220	5	NA	31300000	ug/kg
67792	752212	2083904	4.2	4.4	Toluene	400	5	NA	31300000	ug/kg
67792	752212	2083904	6.2	6.4	Toluene	140	5	NA	31300000	ug/kg
67792	752212	2083904	9.9	10.1	Toluene	100	5	NA	31300000	ug/kg

Table 4
Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
67792	752212	2083904	5.7	12.1	Barium	459	20	289.38	26400	mg/kg
67792	752212	2083904	11.9	12.1	Toluene	310	5	NA	31300000	ug/kg
67892	752216	2083928	1.1	1.3	Toluene	190	5	NA	31300000	ug/kg
67892	752216	2083928	3.5	3.7	Toluene	97	5	NA	31300000	ug/kg
67892	752216	2083928	4.6	4.8	Toluene	110	5	NA	31300000	ug/kg
67892	752216	2083928	7.3	7.5	Methylene chloride	54	5	NA	2530000	ug/kg
67892	752216	2083928	7.3	7.5	Toluene	140	5	NA	31300000	ug/kg
67892	752216	2083928	9.9	10.1	Toluene	92	5	NA	31300000	ug/kg
67892	752216	2083928	11.4	11.6	Toluene	180	5	NA	31300000	ug/kg
68092	752225	2083979	1.5	1.7	Toluene	13	5	NA	31300000	ug/kg
68092	752225	2083979	3.2	3.4	Toluene	220	5	NA	31300000	ug/kg
68092	752225	2083979	4.9	5.1	Toluene	140	5	NA	31300000	ug/kg
68092	752225	2083979	6.3	6.5	Toluene	260	5	NA	31300000	ug/kg
68092	752225	2083979	10	10.2	Toluene	210	5	NA	31300000	ug/kg
68092	752225	2083979	5.6	12.1	Barium	723	20	289.38	26400	mg/kg
68092	752225	2083979	11.9	12.1	Toluene	330	5	NA	31300000	ug/kg
68192	752228	2084001	0.8	1.1	Toluene	67	5	NA	31300000	ug/kg
68192	752228	2084001	3.1	3.4	Toluene	68	5	NA	31300000	ug/kg
68192	752228	2084001	5.7	6	Toluene	16	5	NA	31300000	ug/kg
68192	752228	2084001	6.7	7	Toluene	45	5	NA	31300000	ug/kg
68192	752228	2084001	9.9	10.2	Toluene	85	5	NA	31300000	ug/kg
68192	752228	2084001	11.9	12.1	Toluene	83	5	NA	31300000	ug/kg
68192	752228	2084001	6	13	Barium	606	20	289.38	26400	mg/kg
68292	752403	2083903	0.7	0.9	Toluene	36	5	NA	31300000	ug/kg
68292	752403	2083903	7	7.2	Toluene	6	5	NA	31300000	ug/kg
68292	752403	2083903	11.9	12.1	Toluene	7	5	NA	31300000	ug/kg
68292	752403	2083903	6.2	12.4	Barium	354	20	289.38	26400	mg/kg
68392	752302	2083872	0.6	0.8	Toluene	19	5	NA	31300000	ug/kg
68392	752302	2083872	6	12.3	Barium	2970	20	289.38	26400	mg/kg

Table 4
Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
68492	752308	2083898	0.9	1.1	Toluene	11	5	NA	31300000	ug/kg
68492	752308	2083898	3.5	3.7	Toluene	12	5	NA	31300000	ug/kg
68492	752308	2083898	5.1	5.3	2-Butanone	140	100	NA	192000000	ug/kg
68492	752308	2083898	5.1	5.3	Toluene	27	5	NA	31300000	ug/kg
68492	752308	2083898	7	7.2	Toluene	29	5	NA	31300000	ug/kg
68492	752308	2083898	9.7	9.9	Toluene	25	5	NA	31300000	ug/kg
68492	752308	2083898	6	12.1	Plutonium-239/240	0.023	0	0.02	50	pCi/g
68492	752308	2083898	11.9	12.1	Toluene	22	5	NA	31300000	ug/kg
68592	752315	2083924	0.8	1	Toluene	39	5	NA	31300000	ug/kg
68592	752315	2083924	2.8	3	Toluene	8	5	NA	31300000	ug/kg
68592	752315	2083924	5.6	5.8	Toluene	30	5	NA	31300000	ug/kg
68592	752315	2083924	0	6.2	Plutonium-239/240	0.030	0	0.02	50	pCi/g
68592	752315	2083924	6.6	6.8	Toluene	25	5	NA	31300000	ug/kg
68592	752315	2083924	9.8	10	Toluene	36	5	NA	31300000	ug/kg
68592	752315	2083924	11.8	12	Toluene	25	5	NA	31300000	ug/kg
68692	752319	2083946	1.1	1.3	Toluene	41	5	NA	31300000	ug/kg
68692	752319	2083946	3.2	3.4	Toluene	51	5	NA	31300000	ug/kg
68692	752319	2083946	0	5.8	Strontium	248	40	211.38	613000	mg/kg
68692	752319	2083946	5.6	5.8	Toluene	15	5	NA	31300000	ug/kg
68692	752319	2083946	9.7	9.9	Toluene	23	5	NA	31300000	ug/kg
68692	752319	2083946	11.8	12	Toluene	32	5	NA	31300000	ug/kg
68792	752324	2083973	0.9	1.1	Toluene	230	5	NA	31300000	ug/kg
68792	752324	2083973	2.4	2.6	Toluene	59	5	NA	31300000	ug/kg
68792	752324	2083973	4.6	4.8	Toluene	32	5	NA	31300000	ug/kg
68792	752324	2083973	0	5.4	Strontium	258	40	211.38	613000	mg/kg
68792	752324	2083973	6.7	6.9	Toluene	9	5	NA	31300000	ug/kg
68792	752324	2083973	9.8	10	Toluene	20	5	NA	31300000	ug/kg
68792	752324	2083973	12	12.2	Toluene	17	5	NA	31300000	ug/kg
68892	752327	2083999	0.9	1.1	Toluene	64	5	NA	31300000	ug/kg

Table 4
Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
68892	752327	2083999	3.4	3.6	Toluene	27	5	NA	31300000	ug/kg
68892	752327	2083999	4.6	4.8	Toluene	23	5	NA	31300000	ug/kg
68892	752327	2083999	0	5.9	Plutonium-239/240	0.026	0.007	0.02	50	pCi/g
68892	752327	2083999	0	5.9	Strontium	264	40	211.38	613000	mg/kg
68892	752327	2083999	7.5	7.7	Toluene	26	5	NA	31300000	ug/kg
68892	752327	2083999	9.8	10	Toluene	27	5	NA	31300000	ug/kg
68892	752327	2083999	11.8	12.8	Toluene	26	5	NA	31300000	ug/kg
68992	752532	2084328	3.1	3.3	Toluene	41	5	NA	31300000	ug/kg
68992	752532	2084328	4.5	4.7	Toluene	27	5	NA	31300000	ug/kg
68992	752532	2084328	0	6.2	Plutonium-239/240	0.031	0.004	0.02	50	pCi/g
68992	752532	2084328	8.5	8.7	Toluene	44	5	NA	31300000	ug/kg
68992	752532	2084328	9.8	10	Toluene	11	5	NA	31300000	ug/kg
68992	752532	2084328	11.4	11.6	Toluene	14	5	NA	31300000	ug/kg
68992	752532	2084328	6.2	12.1	Barium	679	20	289.38	26400	mg/kg
69092	752533	2084352	0.5	0.7	Toluene	590	5	NA	31300000	ug/kg
69092	752533	2084352	2.5	2.7	Toluene	76	5	NA	31300000	ug/kg
69092	752533	2084352	4.5	4.7	Toluene	96	5	NA	31300000	ug/kg
69092	752533	2084352	7.1	7.3	Toluene	75	5	NA	31300000	ug/kg
69092	752533	2084352	9.3	9.5	Toluene	11	5	NA	31300000	ug/kg
69092	752533	2084352	11.6	11.8	Toluene	15	5	NA	31300000	ug/kg
69192	752536	2084380	3.8	4	Toluene	13	5	NA	31300000	ug/kg
69192	752536	2084380	5	5.2	Toluene	14	5	NA	31300000	ug/kg
69192	752536	2084380	8.8	9	Toluene	17	5	NA	31300000	ug/kg
69192	752536	2084380	6.2	12.1	Barium	367	20	289.38	26400	mg/kg
69192	752536	2084380	11.9	12.1	Toluene	21	5	NA	31300000	ug/kg
69292	752537	2084402	0.6	0.8	Toluene	120	5	NA	31300000	ug/kg
69292	752537	2084402	3.3	3.5	Toluene	7	5	NA	31300000	ug/kg
69292	752537	2084402	0	4.9	Plutonium-239/240	0.037	0	0.02	50	pCi/g
69292	752537	2084402	4.7	4.9	Toluene	5	5	NA	31300000	ug/kg

Table 4
Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
69292	752537	2084402	7.2	7.4	Toluene	13	5	NA	31300000	ug/kg
69292	752537	2084402	9.8	10	Toluene	25	5	NA	31300000	ug/kg
69292	752537	2084402	11.7	11.9	Toluene	13	5	NA	31300000	ug/kg
69392	752540	2084427	0.6	0.8	Toluene	28	5	NA	31300000	ug/kg
69392	752540	2084427	3.2	3.4	Toluene	6	5	NA	31300000	ug/kg
69392	752540	2084427	0	5.2	Plutonium-239/240	0.026	0	0.02	50	pCi/g
69392	752540	2084427	0	5.2	Strontium	250	40	211.38	613000	mg/kg
69392	752540	2084427	5	5.2	Toluene	19	5	NA	31300000	ug/kg
69392	752540	2084427	5.8	6	Toluene	13	5	NA	31300000	ug/kg
69392	752540	2084427	7.2	7.4	Toluene	9	5	NA	31300000	ug/kg
69392	752540	2084427	8.4	8.6	Toluene	5	5	NA	31300000	ug/kg
69392	752540	2084427	12	12.2	Toluene	51	5	NA	31300000	ug/kg
70593	752100	2082390	0	2	Toluene	710	5	NA	31300000	ug/kg
70593	752100	2082390	2	4	Toluene	70	5	NA	31300000	ug/kg
70593	752100	2082390	4	6	Toluene	110	5	NA	31300000	ug/kg
70593	752100	2082390	6	8	Toluene	90	5	NA	31300000	ug/kg
70593	752100	2082390	8	10	Toluene	76	5	NA	31300000	ug/kg
70593	752100	2082390	10	12	Toluene	110	5	NA	31300000	ug/kg
70593	752100	2082390	12	14	Toluene	64	5	NA	31300000	ug/kg
70593	752100	2082390	14	16	Toluene	120	5	NA	31300000	ug/kg
70593	752100	2082390	16	18	bis(2-Ethylhexyl)phthalate	1800	660	NA	1970000	ug/kg
70593	752100	2082390	16	18	Toluene	92	5	NA	31300000	ug/kg
70593	752100	2082390	18	20	Toluene	51	5	NA	31300000	ug/kg
70593	752100	2082390	20	21.7	Toluene	67	5	NA	31300000	ug/kg
70593	752100	2082390	22	26	Methylene chloride	10	5	NA	2530000	ug/kg
70593	752100	2082390	22	26	Toluene	330	5	NA	31300000	ug/kg
70593	752100	2082390	26	30	Methylene chloride	11	5	NA	2530000	ug/kg
70593	752100	2082390	26	30	Toluene	220	5	NA	31300000	ug/kg
70593	752100	2082390	30.4	34.1	Toluene	300	5	NA	31300000	ug/kg

Table 4

Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
70593	752100	2082390	34.1	38.1	Toluene	120	5	NA	31300000	ug/kg
70593	752100	2082390	38.1	42.1	Toluene	240	5	NA	31300000	ug/kg
70593	752100	2082390	38.1	42.1	Uranium-238	1.505	0.024	1.49	351	pCi/g
70593	752100	2082390	42.1	46.1	Toluene	300	5	NA	31300000	ug/kg
70593	752100	2082390	46.1	50.1	Toluene	90	5	NA	31300000	ug/kg
70593	752100	2082390	50.1	54.1	Toluene	240	5	NA	31300000	ug/kg
70593	752100	2082390	54.1	58.1	Barium	330	20	289.38	26400	mg/kg
70593	752100	2082390	54.1	58.1	Toluene	360	5	NA	31300000	ug/kg
70593	752100	2082390	54.1	58.1	Uranium-234	3.163	0	2.64	300	pCi/g
70593	752100	2082390	54.1	58.1	Uranium-238	2.782	0	1.49	351	pCi/g
71093	753031	2084992	0	2.1	Nitrate	2	1	NA	1000000	mg/kg
71093	753031	2084992	0	2.1	Nitrite	20000	1	NA	102000	mg/kg
71093	753031	2084992	0	2.1	Toluene	770	5	NA	31300000	ug/kg
71093	753031	2084992	2.1	4.1	Toluene	860	5	NA	31300000	ug/kg
71093	753031	2084992	4.1	6.1	Barium	624	20	289.38	26400	mg/kg
71093	753031	2084992	4.1	6.1	Toluene	620	5	NA	31300000	ug/kg
71093	753031	2084992	8.4	12.1	Toluene	290	5	NA	31300000	ug/kg
71093	753031	2084992	12.1	16.1	Toluene	390	5	NA	31300000	ug/kg
71093	753031	2084992	16.1	20.1	Toluene	580	5	NA	31300000	ug/kg
71093	753031	2084992	20.1	24.1	Toluene	700	5	NA	31300000	ug/kg
71093	753031	2084992	24.1	28.1	Toluene	540	5	NA	31300000	ug/kg
71093	753031	2084992	28.1	32.1	Toluene	120	5	NA	31300000	ug/kg
71193	752566	2082717	0	2	Plutonium-239/240	0.028	0	0.02	50	pCi/g
71193	752566	2082717	2	4	Barium	614	20	289.38	26400	mg/kg
71193	752566	2082717	2	4	Methylene chloride	5	5	NA	2530000	ug/kg
71193	752566	2082717	2	4	Toluene	76	5	NA	31300000	ug/kg
71193	752566	2082717	4	6	Barium	542	20	289.38	26400	mg/kg
71193	752566	2082717	4	6	Toluene	130	5	NA	31300000	ug/kg
71193	752566	2082717	6	8	Toluene	23	5	NA	31300000	ug/kg

Table 4
Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
71193	752566	2082717	8	10	Methylene chloride	5	5	NA	2530000	ug/kg
71193	752566	2082717	8	10	Toluene	31	5	NA	31300000	ug/kg
71193	752566	2082717	10	12	Toluene	160	5	NA	31300000	ug/kg
71193	752566	2082717	12	13	Barium	325	20	289.38	26400	mg/kg
71193	752566	2082717	12	13	Manganese	1440	3	901.62	3480	mg/kg
71193	752566	2082717	12	13	Methylene chloride	5	5	NA	2530000	ug/kg
71193	752566	2082717	12	13	Toluene	110	5	NA	31300000	ug/kg
71193	752566	2082717	14	15.5	Toluene	53	5	NA	31300000	ug/kg
71193	752566	2082717	16	16.8	Methylene chloride	6	5	NA	2530000	ug/kg
71193	752566	2082717	16	16.8	Toluene	220	5	NA	31300000	ug/kg
71193	752566	2082717	18	20	Toluene	230	5	NA	31300000	ug/kg
71193	752566	2082717	20	24	Methylene chloride	6	5	NA	2530000	ug/kg
71193	752566	2082717	20	24	Toluene	380	5	NA	31300000	ug/kg
71193	752566	2082717	24	28	Methylene chloride	5	5	NA	2530000	ug/kg
71193	752566	2082717	24	28	Toluene	320	5	NA	31300000	ug/kg
71193	752566	2082717	28	32	Methylene chloride	7	5	NA	2530000	ug/kg
71193	752566	2082717	28	32	Toluene	370	5	NA	31300000	ug/kg
71193	752566	2082717	32	36	Methylene chloride	6	5	NA	2530000	ug/kg
71193	752566	2082717	32	36	Toluene	530	5	NA	31300000	ug/kg
71793	752182	2082961	0	2	Americium-241	0.041	0.004	0.02	76	pCi/g
71793	752182	2082961	0	2	Plutonium-239/240	0.214	0.005	0.02	50	pCi/g
71793	752182	2082961	0	2	Toluene	190	5	NA	31300000	ug/kg
71793	752182	2082961	2	4	Acetone	410	100	NA	102000000	ug/kg
71793	752182	2082961	2	4	Plutonium-239/240	0.024	0.021	0.02	50	pCi/g
71793	752182	2082961	2	4	Toluene	460	5	NA	31300000	ug/kg
71793	752182	2082961	4	5	Toluene	190	5	NA	31300000	ug/kg
71793	752182	2082961	6.7	8	Toluene	230	5	NA	31300000	ug/kg
71793	752182	2082961	10.4	12	Toluene	370	5	NA	31300000	ug/kg
71793	752182	2082961	12	14	Methylene chloride	14	5	NA	2530000	ug/kg

Table 4
Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
71793	752182	2082961	12	14	Toluene	350	5	NA	31300000	ug/kg
71793	752182	2082961	14	16	Methylene chloride	13	5	NA	2530000	ug/kg
71793	752182	2082961	14	16	Toluene	220	5	NA	31300000	ug/kg
71793	752182	2082961	16	18	Toluene	330	5	NA	31300000	ug/kg
71793	752182	2082961	20	22	Methylene chloride	12	5	NA	2530000	ug/kg
71793	752182	2082961	20	22	Toluene	330	5	NA	31300000	ug/kg
71793	752182	2082961	22	24	Toluene	260	5	NA	31300000	ug/kg
71793	752182	2082961	24	26	Toluene	240	5	NA	31300000	ug/kg
71793	752182	2082961	26	28	Toluene	170	5	NA	31300000	ug/kg
71793	752182	2082961	28	32	Toluene	230	5	NA	31300000	ug/kg
71793	752182	2082961	32	34	Toluene	1300	5	NA	31300000	ug/kg
71793	752182	2082961	32	34	Uranium-238	1.64	0.014	1.49	351	pCi/g
71993	752549	2083211	0	2.2	Plutonium-239/240	0.130	0.036	0.02	50	pCi/g
71993	752549	2083211	0	2.2	Toluene	350	5	NA	31300000	ug/kg
71993	752549	2083211	6.4	8.4	Plutonium-239/240	0.052	0	0.02	50	pCi/g
71993	752549	2083211	6.4	8.4	Toluene	310	5	NA	31300000	ug/kg
71993	752549	2083211	8.4	10.4	Fluoranthene	730	660	NA	27200000	ug/kg
71993	752549	2083211	8.4	10.4	Pyrene	820	660	NA	22100000	ug/kg
71993	752549	2083211	8.4	10.4	Toluene	3300	5	NA	31300000	ug/kg
71993	752549	2083211	10.4	12.4	Benzo(a)anthracene	1100	660	NA	34900	ug/kg
71993	752549	2083211	10.4	12.4	Benzo(a)pyrene	990	660	NA	3490	ug/kg
71993	752549	2083211	10.4	12.4	Benzo(b)fluoranthene	1500	660	NA	34900	ug/kg
71993	752549	2083211	10.4	12.4	Benzo(k)fluoranthene	520	410	NA	349000	ug/kg
71993	752549	2083211	10.4	12.4	Chrysene	1000	660	NA	3490000	ug/kg
71993	752549	2083211	10.4	12.4	Fluoranthene	2800	660	NA	27200000	ug/kg
71993	752549	2083211	10.4	12.4	Pyrene	2800	660	NA	22100000	ug/kg
71993	752549	2083211	12.4	14.4	Di-n-butylphthalate	4600	430	NA	73700000	ug/kg
71993	752549	2083211	12.4	14.4	Fluoranthene	900	660	NA	27200000	ug/kg
71993	752549	2083211	12.4	14.4	Plutonium-239/240	0.112	0	0.02	50	pCi/g

Table 4

Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
71993	752549	2083211	12.4	14.4	Pyrene	930	660	NA	22100000	ug/kg
71993	752549	2083211	12.4	14.4	Zinc	195	4	139.1	307000	mg/kg
71993	752549	2083211	36.4	38.4	Styrene	47	5	NA	123000000	ug/kg
71993	752549	2083211	36.4	38.4	Toluene	370	5	NA	31300000	ug/kg
71993	752549	2083211	40.5	44.5	Americium-241	0.033	0	0.02	76	pCi/g
71993	752549	2083211	40.5	44.5	Plutonium-239/240	0.266	0	0.02	50	pCi/g
71993	752549	2083211	40.5	44.5	Toluene	330	5	NA	31300000	ug/kg
72193	752774	2083813	0	2.3	Toluene	15	5	NA	31300000	ug/kg
72193	752774	2083813	12.3	14.3	1,1,1-Trichloroethane	6	5	NA	79700000	ug/kg
72193	752774	2083813	12.3	14.3	2-Butanone	260	100	NA	192000000	ug/kg
72193	752774	2083813	12.3	14.3	4-Methyl-2-pentanone	11	10	NA	16400000	ug/kg
72193	752774	2083813	12.3	14.3	Acetone	590	100	NA	102000000	ug/kg
72193	752774	2083813	12.3	14.3	Benzo(a)anthracene	840	660	NA	34900	ug/kg
72193	752774	2083813	12.3	14.3	Benzo(a)pyrene	710	660	NA	3490	ug/kg
72193	752774	2083813	12.3	14.3	Benzo(b)fluoranthene	1100	660	NA	34900	ug/kg
72193	752774	2083813	12.3	14.3	Benzo(k)fluoranthene	350	340	NA	349000	ug/kg
72193	752774	2083813	12.3	14.3	Chrysene	920	660	NA	3490000	ug/kg
72193	752774	2083813	12.3	14.3	Ethylbenzene	18	5	NA	4250000	ug/kg
72193	752774	2083813	12.3	14.3	Fluoranthene	1700	660	NA	27200000	ug/kg
72193	752774	2083813	12.3	14.3	Pyrene	2200	660	NA	22100000	ug/kg
72193	752774	2083813	12.3	14.3	Styrene	13	5	NA	123000000	ug/kg
72193	752774	2083813	12.3	14.3	Toluene	280	5	NA	31300000	ug/kg
72193	752774	2083813	12.3	14.3	Trichloroethene	13	5	NA	19600	ug/kg
72193	752774	2083813	12.3	14.3	Xylene	28	5	NA	2040000	ug/kg
72193	752774	2083813	16.3	18.3	1,1,1-Trichloroethane	19	5	NA	79700000	ug/kg
72193	752774	2083813	16.3	18.3	1,1-Dichloroethane	18	5	NA	22500000	ug/kg
72193	752774	2083813	16.3	18.3	2-Butanone	930	100	NA	192000000	ug/kg
72193	752774	2083813	16.3	18.3	4-Methyl-2-pentanone	360	13	NA	16400000	ug/kg
72193	752774	2083813	16.3	18.3	Acetone	830	100	NA	102000000	ug/kg

Table 4

Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
72193	752774	2083813	16.3	18.3	Chloroethane	8	5	NA	13200000	ug/kg
72193	752774	2083813	16.3	18.3	Ethylbenzene	34	5	NA	4250000	ug/kg
72193	752774	2083813	16.3	18.3	Styrene	11	5	NA	123000000	ug/kg
72193	752774	2083813	16.3	18.3	Toluene	490	5	NA	31300000	ug/kg
72193	752774	2083813	16.3	18.3	Trichloroethene	18	5	NA	19600	ug/kg
72193	752774	2083813	16.3	18.3	Xylene	43	5	NA	2040000	ug/kg
72193	752774	2083813	20.3	22.3	1,1,1-Trichloroethane	14	5	NA	79700000	ug/kg
72193	752774	2083813	20.3	22.3	1,1-Dichloroethane	15	5	NA	22500000	ug/kg
72193	752774	2083813	20.3	22.3	2-Butanone	390	100	NA	192000000	ug/kg
72193	752774	2083813	20.3	22.3	4-Methyl-2-pentanone	260	13	NA	16400000	ug/kg
72193	752774	2083813	20.3	22.3	Acetone	230	100	NA	102000000	ug/kg
72193	752774	2083813	20.3	22.3	Ethylbenzene	37	5	NA	4250000	ug/kg
72193	752774	2083813	20.3	22.3	Styrene	5	5	NA	123000000	ug/kg
72193	752774	2083813	20.3	22.3	Toluene	3400	5	NA	31300000	ug/kg
72193	752774	2083813	20.3	22.3	Trichloroethene	11	5	NA	19600	ug/kg
72193	752774	2083813	20.3	22.3	Xylene	110	5	NA	2040000	ug/kg
72193	752774	2083813	24.3	26.3	2-Butanone	400	100	NA	192000000	ug/kg
72193	752774	2083813	24.3	26.3	4-Methyl-2-pentanone	19	12	NA	16400000	ug/kg
72193	752774	2083813	24.3	26.3	Acetone	1600	100	NA	102000000	ug/kg
72193	752774	2083813	24.3	26.3	Barium	316	20	289.38	26400	mg/kg
72193	752774	2083813	24.3	26.3	Ethylbenzene	8	5	NA	4250000	ug/kg
72193	752774	2083813	24.3	26.3	Methylene chloride	9	5	NA	2530000	ug/kg
72193	752774	2083813	24.3	26.3	Toluene	1400	5	NA	31300000	ug/kg
72193	752774	2083813	24.3	26.3	Xylene	11	5	NA	2040000	ug/kg
72193	752774	2083813	26.3	28.3	Barium	301	20	289.38	26400	mg/kg
72193	752774	2083813	28.3	30.3	Acetone	190	100	NA	102000000	ug/kg
72193	752774	2083813	28.3	30.3	Barium	333	20	289.38	26400	mg/kg
72193	752774	2083813	28.3	30.3	Ethylbenzene	17	5	NA	4250000	ug/kg
72193	752774	2083813	28.3	30.3	Toluene	450	5	NA	31300000	ug/kg

Table 4

Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
72193	752774	2083813	28.3	30.3	Xylene	19	5	NA	2040000	ug/kg
72193	752774	2083813	38.3	40.3	Toluene	100	5	NA	31300000	ug/kg
72193	752774	2083813	40.3	44.2	Plutonium-239/240	0.030	0.008	0.02	50	pCi/g
72193	752774	2083813	40.3	44.2	Toluene	100	5	NA	31300000	ug/kg
72193	752774	2083813	44.2	48.3	Toluene	150	5	NA	31300000	ug/kg
72193	752774	2083813	44.2	48.3	Uranium-238	1.599	0.046	1.49	351	pCi/g
72193	752774	2083813	48.3	52.3	Iron	56500	1.7	41046.52	307000	mg/kg
72193	752774	2083813	48.3	52.3	Manganese	1160	3	901.62	3480	mg/kg
72193	752774	2083813	48.3	52.3	Plutonium-239/240	0.024	0.007	0.02	50	pCi/g
72193	752774	2083813	48.3	52.3	Toluene	360	5	NA	31300000	ug/kg
72193	752774	2083813	48.3	52.3	Uranium-238	1.773	0.058	1.49	351	pCi/g
72193	752774	2083813	52.3	56.3	Toluene	120	5	NA	31300000	ug/kg
72193	752774	2083813	56.3	60	Toluene	350	5	NA	31300000	ug/kg
76792	752546	2084618	0	2	Methylene chloride	5	5	NA	2530000	ug/kg
76792	752546	2084618	0	2	Toluene	91	5	NA	31300000	ug/kg
76792	752546	2084618	4	6	2-Butanone	740	100	NA	192000000	ug/kg
76792	752546	2084618	4	6	Toluene	26	5	NA	31300000	ug/kg
76792	752546	2084618	6	8	2-Butanone	230	100	NA	192000000	ug/kg
76792	752546	2084618	6	8	Toluene	12	5	NA	31300000	ug/kg
76992	752561	2084500	3.7	3.9	2-Butanone	560	100	NA	192000000	ug/kg
76992	752561	2084500	3.7	3.9	Toluene	9	5	NA	31300000	ug/kg
76992	752561	2084500	8.6	8.8	2-Butanone	760	100	NA	192000000	ug/kg
76992	752561	2084500	8.6	8.8	Toluene	21	5	NA	31300000	ug/kg
76992	752561	2084500	11	11.2	2-Butanone	970	100	NA	192000000	ug/kg
76992	752561	2084500	11	11.2	Toluene	49	5	NA	31300000	ug/kg
77392	752243	2084299	3.8	4	2-Butanone	470	100	NA	192000000	ug/kg
77392	752243	2084299	3.8	4	Toluene	7	5	NA	31300000	ug/kg
77392	752243	2084299	7.3	7.5	2-Butanone	950	100	NA	192000000	ug/kg
77392	752243	2084299	7.3	7.5	Toluene	33	5	NA	31300000	ug/kg

Table 4
Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS120294	752889	2084864	0	0.83	Nitrite	1.22	0.5	NA	102000	mg/kg
SS120394	752864	2084890	0	0.83	Lead	30.8	0.6	24.97	1000	mg/kg
SS120394	752864	2084890	0	0.83	Nitrite	1.72	0.5	NA	102000	mg/kg
SS120394	752864	2084890	0	0.83	Plutonium-239/240	0.041	0.015	0.02	50	pCi/g
SS120494	752838	2084866	0	0.83	Lead	30.9	0.6	24.97	1000	mg/kg
SS120494	752838	2084866	0	0.83	Nitrite	2.84	0.5	NA	102000	mg/kg
SS120494	752838	2084866	0	0.83	Plutonium-239/240	0.036	0.01	0.02	50	pCi/g
SS700393	752743	2084537	0	0.83	Nitrite	1	1	NA	102000	mg/kg
SS700393	752743	2084537	0	0.83	Plutonium-239/240	0.030	0.007	0.02	50	pCi/g
SS700493	752791	2084535	0	0.83	Nitrite	2	1	NA	102000	mg/kg
SS700493	752791	2084535	0	0.83	Plutonium-239/240	0.039	0.015	0.02	50	pCi/g
SS700693	752741	2084488	0	0.83	Nitrite	1	1	NA	102000	mg/kg
SS700793	752692	2084489	0	0.83	Nitrite	1	1	NA	102000	mg/kg
SS700793	752692	2084489	0	0.83	Plutonium-239/240	0.043	0.004	0.02	50	pCi/g
SS700893	752694	2084440	0	0.83	Nitrite	2	1	NA	102000	mg/kg
SS700893	752694	2084440	0	0.83	Plutonium-239/240	0.032	0.010	0.02	50	pCi/g
SS701193	752842	2084437	0	0.83	Nitrite	5	1	NA	102000	mg/kg
SS701193	752842	2084437	0	0.83	Plutonium-239/240	0.022	0.009	0.02	50	pCi/g
SS701293	752844	2084388	0	0.83	Nitrite	2	1	NA	102000	mg/kg
SS701393	752795	2084390	0	0.83	Nitrite	3	1	NA	102000	mg/kg
SS701393	752795	2084390	0	0.83	Plutonium-239/240	0.021	0.007	0.02	50	pCi/g
SS701593	752697	2084395	0	0.83	Barium	352	20	289.38	26400	mg/kg
SS701793	752747	2084344	0	0.83	Plutonium-239/240	0.026	0.003	0.02	50	pCi/g
SS701893	752798	2084343	0	0.83	Nitrite	2	1	NA	102000	mg/kg
SS701993	752846	2084343	0	0.83	Nitrite	2	1	NA	102000	mg/kg
SS702193	752799	2084293	0	0.83	Nitrite	4	1	NA	102000	mg/kg
SS702393	752700	2084291	0	0.83	Nitrite	1	1	NA	102000	mg/kg
SS702393	752700	2084291	0	0.83	Plutonium-239/240	0.046	0.005	0.02	50	pCi/g
SS702593	752748	2084239	0	0.83	Nitrite	2	1	NA	102000	mg/kg

Table 4
Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS702593	752748	2084239	0	0.83	Plutonium-239/240	0.037	0.012	0.02	50	pCi/g
SS702693	752797	2084237	0	0.83	Nitrite	3	1	NA	102000	mg/kg
SS702693	752797	2084237	0	0.83	Plutonium-239/240	0.046	0.013	0.02	50	pCi/g
SS702793	752846	2084234	0	0.83	Plutonium-239/240	0.025	0.013	0.02	50	pCi/g
SS702893	752846	2084184	0	0.83	Plutonium-239/240	0.042	0.006	0.02	50	pCi/g
SS702993	752798	2084186	0	0.83	Nitrite	3	1	NA	102000	mg/kg
SS702993	752798	2084186	0	0.83	Plutonium-239/240	0.061	0.005	0.02	50	pCi/g
SS703093	752750	2084186	0	0.83	Barium	320	20	289.38	26400	mg/kg
SS703093	752750	2084186	0	0.83	Nitrite	1	1	NA	102000	mg/kg
SS703193	752700	2084189	0	0.83	Barium	305	20	289.38	26400	mg/kg
SS703593	752803	2084085	0	0.83	Americium-241	0.025	0.006	0.02	76	pCi/g
SS703593	752803	2084085	0	0.83	Barium	365	20	289.38	26400	mg/kg
SS703593	752803	2084085	0	0.83	Nitrite	2	1	NA	102000	mg/kg
SS704193	752805	2083985	0	0.83	Barium	291	20	289.38	26400	mg/kg
SS705593	752901.8	2083980	0	0.83	Barium	295	20	289.38	26400	mg/kg
SS705593	752901.8	2083980	0	0.83	Nitrite	3	1	NA	102000	mg/kg
SS706193	753013	2084070	0	0.83	Nitrite	1	1	NA	102000	mg/kg
SS706393	752915	2084077	0	0.83	Nitrite	5	1	NA	102000	mg/kg
SS707093	753118	2084150	0	0.83	Nitrite	1	1	NA	102000	mg/kg
SS707293	753023	2084159	0	0.83	Nitrite	5	1	NA	102000	mg/kg
SS707693	753076	2084204	0	0.83	Nitrite	4	1	NA	102000	mg/kg
SS707693	753076	2084204	0	0.83	Plutonium-239/240	0.026	0.011	0.02	50	pCi/g
SS707793	753124	2084201	0	0.83	Nitrite	4	1	NA	102000	mg/kg
SS707793	753124	2084201	0	0.83	Plutonium-239/240	0.027	0.004	0.02	50	pCi/g
SS707893	753173	2084204	0	0.83	Americium-241	0.022	0.007	0.02	76	pCi/g
SS707893	753173	2084204	0	0.83	Nitrite	5	1	NA	102000	mg/kg
SS707893	753173	2084204	0	0.83	Plutonium-239/240	0.088	0.015	0.02	50	pCi/g
SS707993	753177	2084253	0	0.83	Americium-241	0.023	0.008	0.02	76	pCi/g
SS707993	753177	2084253	0	0.83	Barium	383	20	289.38	26400	mg/kg

Table 4
Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS708093	753128	2084256	0	0.83	Barium	546	20	289.38	26400	mg/kg
SS708093	753128	2084256	0	0.83	Nitrite	7	1	NA	102000	mg/kg
SS708193	753080	2084258	0	0.83	Nitrite	3	1	NA	102000	mg/kg
SS708193	753080	2084258	0	0.83	Plutonium-239/240	0.043	0.008	0.02	50	pCi/g
SS708293	753028	2084260	0	0.83	Plutonium-239/240	0.043	0.003	0.02	50	pCi/g
SS708393	753081	2084307	0	0.83	Nitrite	4	1	NA	102000	mg/kg
SS708393	753081	2084307	0	0.83	Plutonium-239/240	0.033	0.012	0.02	50	pCi/g
SS708493	753129	2084302	0	0.83	Barium	544	20	289.38	26400	mg/kg
SS708493	753129	2084302	0	0.83	Nitrite	3	1	NA	102000	mg/kg
SS708593	753179	2084302	0	0.83	Barium	375	20	289.38	26400	mg/kg
SS708593	753179	2084302	0	0.83	Nitrite	2	1	NA	102000	mg/kg
SS708693	753178	2084360	0	0.83	Barium	374	20	289.38	26400	mg/kg
SS708793	753130	2084362	0	0.83	Barium	295	20	289.38	26400	mg/kg
SS708793	753130	2084362	0	0.83	Nitrite	3	1	NA	102000	mg/kg
SS708893	753084	2084364	0	0.83	Nitrite	4	1	NA	102000	mg/kg
SS708893	753084	2084364	0	0.83	Plutonium-239/240	0.024	0.008	0.02	50	pCi/g
SS709093	753132	2084410	0	0.83	Nitrite	3	1	NA	102000	mg/kg
SS709093	753132	2084410	0	0.83	Plutonium-239/240	0.026	0.010	0.02	50	pCi/g
SS709193	753182	2084412	0	0.83	Barium	391	20	289.38	26400	mg/kg
SS709193	753182	2084412	0	0.83	Nitrite	3	1	NA	102000	mg/kg
SS709593	753270	2084613	0	0.83	Barium	413	20	289.38	26400	mg/kg
SS709593	753270	2084613	0	0.83	Nitrite	4	1	NA	102000	mg/kg
SS709793	753074	2084649	0	0.83	Nitrite	4	1	NA	102000	mg/kg
SS709793	753074	2084649	0	0.83	Plutonium-239/240	0.071	0.011	0.02	50	pCi/g
SS709993	752882	2084704	0	0.83	Nitrite	5	1	NA	102000	mg/kg
SS709993	752882	2084704	0	0.83	Plutonium-239/240	0.051	0.007	0.02	50	pCi/g
SS710293	752620	2084725	0	0.83	Nitrite	5	1	NA	102000	mg/kg
SS710293	752620	2084725	0	0.83	Plutonium-239/240	0.029	0.004	0.02	50	pCi/g
SS710693	753084	2084789	0	0.83	Nitrite	7	1	NA	102000	mg/kg

Table 4
Subsurface Soil Sampling Results Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Location Code	Latitude	Longitude	Start Depth (feet)	End Depth (feet)	Analyte	Result	MDL	Background Means Plus 2 SD	Wildlife Refuge Worker Action Level	Units
SS710893	753279	2084788	0	0.83	Nitrite	1	1	NA	102000	mg/kg
SS711493	752864	2084865	0	0.83	Americium-241	0.058	0.005	0.02	76	pCi/g
SS711493	752864	2084865	0	0.83	Plutonium-239/240	0.424	0.010	0.02	50	pCi/g
SS711693	752694	2084860	0	0.83	Nitrite	4	1	NA	102000	mg/kg
SS711993	752624	2085027	0	0.83	Nitrite	4	1	NA	102000	mg/kg
SS711993	752624	2085027	0	0.83	Plutonium-239/240	0.031	0.012	0.02	50	pCi/g
SS712293	752857	2085033	0	0.83	Nitrite	6	1	NA	102000	mg/kg
SS712793	752235	2082598	0	0.83	Toluene	140	5	NA	31300000	ug/kg
SS712993	752206	2082638	0	0.83	Americium-241	0.030	0.004	0.02	76	pCi/g
SS712993	752206	2082638	0	0.83	Plutonium-239/240	0.099	0.012	0.02	50	pCi/g
SS713193	752175	2082678	0	0.83	Plutonium-239/240	0.024	0.013	0.02	50	pCi/g
SS713393	752211	2082671	0	0.83	Plutonium-239/240	0.023	0.012	0.02	50	pCi/g
SS713993	752307	2082583	0	0.83	Nitrite	2	1	NA	102000	mg/kg
SS713993	752307	2082583	0	0.83	Plutonium-239/240	0.033	0.014	0.02	50	pCi/g
SS714193	752277	2082624	0	0.83	Americium-241	0.021	0.003	0.02	76	pCi/g
SS714193	752277	2082624	0	0.83	Plutonium-239/240	0.039	0.015	0.02	50	pCi/g
SS714393	752247	2082665	0	0.83	Plutonium-239/240	0.054	0.006	0.02	50	pCi/g
SS715393	752347	2082613	0	0.83	Copper	41.6	1	38.21	40900	mg/kg
SS715793	752289	2082692	0	0.83	Americium-241	0.029	0.002	0.02	76	pCi/g
SS715793	752289	2082692	0	0.83	Plutonium-239/240	0.097	0.006	0.02	50	pCi/g
SS715993	752258	2082733	0	0.83	Plutonium-239/240	0.061	0.007	0.02	50	pCi/g
SS716993	752360	2082683	0	0.83	Americium-241	0.027	0.002	0.02	76	pCi/g
SS716993	752360	2082683	0	0.83	Nitrite	1	1	NA	102000	mg/kg
SS716993	752360	2082683	0	0.83	Plutonium-239/240	0.122	0.017	0.02	50	pCi/g
SS717193	752333	2082719	0	0.83	Plutonium-239/240	0.076	0.018	0.02	50	pCi/g
SS717393	752300	2082761	0	0.83	Americium-241	0.025	0.002	0.02	76	pCi/g
SS717393	752300	2082761	0	0.83	Plutonium-239/240	0.088	0.005	0.02	50	pCi/g

Table 5
Subsurface Soil Summary by Analyte Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Analyte	Total Number Samples Analyzed	Detection Frequency	Average Concentration	Maximum Concentration	Standard Deviation	MDLs	Background Mean Plus 2SD	Wildlife Refuge Worker Action Level	Unit
1,1,1-Trichloroethane	228	0.013	13	19	6.557	5	NA	79700000	ug/kg
1,1-Dichloroethane	229	0.009	16.5	18	2.121	5	NA	22500000	ug/kg
2-Butanone	204	0.103	635.714	1600	342.601	100	NA	192000000	ug/kg
4-Methyl-2-pentanone	219	0.018	162.5	360	175.173	12	NA	16400000	ug/kg
Acetone	227	0.026	641.667	1600	526.058	100	NA	102000000	ug/kg
Americium-241	170	0.065	0.030	0.05813	0.011	0.004	0.02	76	pCi/g
Barium	215	0.149	502.781	2970	467.338	20	289.38	26400	mg/kg
Benzo(a)anthracene	82	0.024	970	1100	183.848	660	NA	34900	ug/kg
Benzo(a)pyrene	82	0.024	850	990	197.990	660	NA	3490	ug/kg
Benzo(b)fluoranthene	81	0.025	1300	1500	282.843	660	NA	34900	ug/kg
Benzo(k)fluoranthene	82	0.024	435	520	120.208	375	NA	349000	ug/kg
bis(2-Ethylhexyl)phthalate	81	0.012	1800	1800	NA	660	NA	1970000	ug/kg
Chloroethane	225	0.004	8	8	NA	5	NA	13200000	ug/kg
Chromium	215	0.005	130	130	NA	2	68.27	268	mg/kg
Chrysene	82	0.024	960	1000	56.569	660	NA	3490000	ug/kg
Copper	215	0.009	46.85	52.1	7.425	1	38.21	40900	mg/kg
Di-n-butylphthalate	82	0.012	4600	4600	NA	430	NA	73700000	ug/kg
Ethylbenzene	229	0.022	22.8	37	12.276	5	NA	4250000	ug/kg
Fluoranthene	82	0.061	1418	2800	857.450	660	NA	27200000	ug/kg
Iron	214	0.005	56500	56500	NA	1.7	41046.52	307000	mg/kg
Lead	46	0.043	30.85	30.9	0.071	0.6	24.97	1000	mg/kg
Manganese	214	0.019	1105.5	1440	252.027	3	901.62	3480	mg/kg
Methylene chloride	229	0.070	10.813	54	11.940	5	NA	2530000	ug/kg
Molybdenum	214	0.005	27.9	27.9	NA	8	25.61	5110	mg/kg
Nitrate	57	0.018	2	2	NA	1	NA	1000000	mg/kg
Nitrite	139	0.353	411.138	20000	2856.709	0.969	NA	102000	mg/kg
Plutonium-239/240	176	0.313	0.059	0.4235	0.068	0.008	0.02	50	pCi/g
Pyrene	82	0.061	1670	2800	841.546	660	NA	22100000	ug/kg

Table 5

Subsurface Soil Summary by Analyte Greater Than Background Means Plus Two Standard Deviations or Method Detection Limit

Analyte	Total Number Samples Analyzed	Detection Frequency	Average Concentration	Maximum Concentration	Standard Deviation	MDLs	Background Mean Plus 2SD	Wildlife Refuge Worker Action Level	Unit
Strontium	214	0.019	255	264	7.394	40	211.38	613000	mg/kg
Styrene	229	0.017	19	47	18.974	5	NA	123000000	ug/kg
Toluene	236	0.843	220.653	3400	436.209	5	NA	31300000	ug/kg
Trichloroethene	229	0.031	12.857	21	5.146	5	NA	19600	ug/kg
Uranium-234	198	0.005	3.163	3.163	NA	0	2.64	300	pCi/g
Uranium-238	198	0.025	1.860	2.782	0.524	0.028	1.49	351	pCi/g
Vanadium	215	0.005	119	119	NA	8	88.49	7150	mg/kg
Xylene	229	0.026	36	110	38.637	5	NA	2040000	ug/kg
Zinc	215	0.005	195	195	NA	4	139.1	307000	mg/kg

Table 6
Subsurface Soil Method Summary by Location

Location Code	Metals	Radionuclides	SVOCs	VOAs	PCBs	Inorganics
00393	43	9	0	132	NA	NA
00493	103		216	190	NA	NA
66892	40	10	0	198	NA	NA
67092	41	8	0	132	NA	NA
67192	43	8	0	198	NA	NA
67292	41	8	0	198	NA	NA
67392	44	10	0	198	NA	NA
67492	42	10	0	198	NA	NA
67592	41	8	0	198	NA	NA
67692	39	8	0	198	NA	NA
67792	41	10	0	198	NA	NA
67892	40	10	0	198	NA	NA
68092	40	8	0	198	NA	NA
68192	43	10	0	198	NA	NA
68292	42	10	0	193	NA	NA
68392	42	8	0	198	NA	NA
68492	42	10	0	198	NA	NA
68592	43	10	0	198	NA	NA
68692	44	10	0	165	NA	NA
68792	44	9	0	198	NA	NA
68892	42	10	0	195	NA	NA
68992	42	10	0	165	NA	NA
69092	42	8	0	198	NA	NA
69192	43	10	0	132	NA	NA
69292	42	10	0	198	NA	NA
69392	42	10	0	219	NA	NA
70593	405	91	1080	646	500	22
71093	210	45	540	295	70	18
71193	297	53	702	397	91	26
71793	317	62	808	451	99	26
71993	146	21	376	132	14	2
72193	254	40	645	397	88	20
76792	0	NA	0	99	NA	NA
76992	0	NA	0	99	NA	NA
77392	0	NA	0	62	NA	NA
SS120294	22	5	0	0	NA	1
SS120394	22	5	0	0	NA	1
SS120494	22	5	0	0	NA	1
SS700293	21	5	0	0	NA	1
SS700393	21	5	0	0	NA	1
SS700493	21	5	0	0	NA	1
SS700593	21	5	0	0	NA	1
SS700693	21	5	0	0	NA	1
SS700793	21	5	0	0	NA	1
SS700893	21	5	0	0	NA	1
SS700993	21	5	0	0	NA	1
SS701193	21	5	0	0	NA	1

Table 6
Subsurface Soil Method Summary by Location

Location Code	Metals	Radionuclides	SVOCs	VOAs	PCBs	Inorganics
SS701293	21	4	0	0	NA	1
SS701393	21	5	0	0	NA	1
SS701493	21	5	0	0	NA	1
SS701593	21	5	0	0	NA	1
SS701793	21	4	0	0	NA	1
SS701893	20	5	0	0	NA	1
SS701993	21	5	0	0	NA	1
SS702093	20	5	0	0	NA	1
SS702193	20	5	0	0	NA	1
SS702293	20	5	0	0	NA	1
SS702393	21	5	0	0	NA	1
SS702593	20	5	0	0	NA	1
SS702693	21	5	0	0	NA	1
SS702793	21	5	0	0	NA	1
SS702893	20	5	0	0	NA	1
SS702993	20	5	0	0	NA	1
SS703093	20	5	0	0	NA	1
SS703193	21	5	0	0	NA	1
SS703593	21	4	0	0	NA	1
SS703793	21	5	0	0	NA	1
SS704193	21	5	0	0	NA	1
SS704393	21	5	0	0	NA	1
SS705393	20	5	0	0	NA	1
SS705593	21		0	0	NA	1
SS706193	21	5	0	0	NA	1
SS706393	21	5	0	0	NA	1
SS707093	21	5	0	0	NA	1
SS707293	21	5	0	0	NA	1
SS707693	21	2	0	0	NA	1
SS707793	21	5	0	0	NA	1
SS707893	21	5	0	0	NA	1
SS707993	21	5	0	0	NA	1
SS708093	21	5	0	0	NA	1
SS708193	21	5	0	0	NA	1
SS708293	21	5	0	0	NA	1
SS708393	21	5	0	0	NA	1
SS708493	21	5	0	0	NA	1
SS708593	21	5	0	0	NA	1
SS708693	21	5	0	0	NA	1
SS708793	21	2	0	0	NA	1
SS708893	21	5	0	0	NA	1
SS709093	21	5	0	0	NA	1
SS709193	21	5	0	0	NA	1
SS709593	21	5	0	0	NA	1
SS709793	21	5	0	0	NA	1
SS709993	21	5	0	0	NA	1
SS710293	21	5	0	0	NA	1

Table 6
Subsurface Soil Method Summary by Location

Location Code	Metals	Radionuclides	SVOCs	VOAs	PCBs	Inorganics
SS710693	21	5	0	0	NA	1
SS710893	21	5	0	0	NA	1
SS711493	21	5	0	0	NA	1
SS711693	21	5	0	0	NA	1
SS711993	21	5	0	0	NA	1
SS712293	21	5	0	0	NA	1
SS712793	15	5	53	33	25	2
SS712993	21	5	0	0	7	1
SS713193	21	5	0	0	7	1
SS713393	21	5	0	0	7	1
SS713993	21	5	0	0	7	1
SS714193	21	5	0	0	7	1
SS714393	21	5	0	0	7	1
SS715393	21	5	0	0	7	1
SS715593	21	5	0	0	7	1
SS715793	21	5	0	0	7	1
SS715993	21	5	0	0	7	1
SS716793	21	5	0	0	7	1
SS716993	21	5	0	0	7	1
SS717193	21	5	0	0	7	1
SS717393	21	5	0	0	7	1
SS719693	21	5	0	0		1
SS719893	21	5	0	0		1

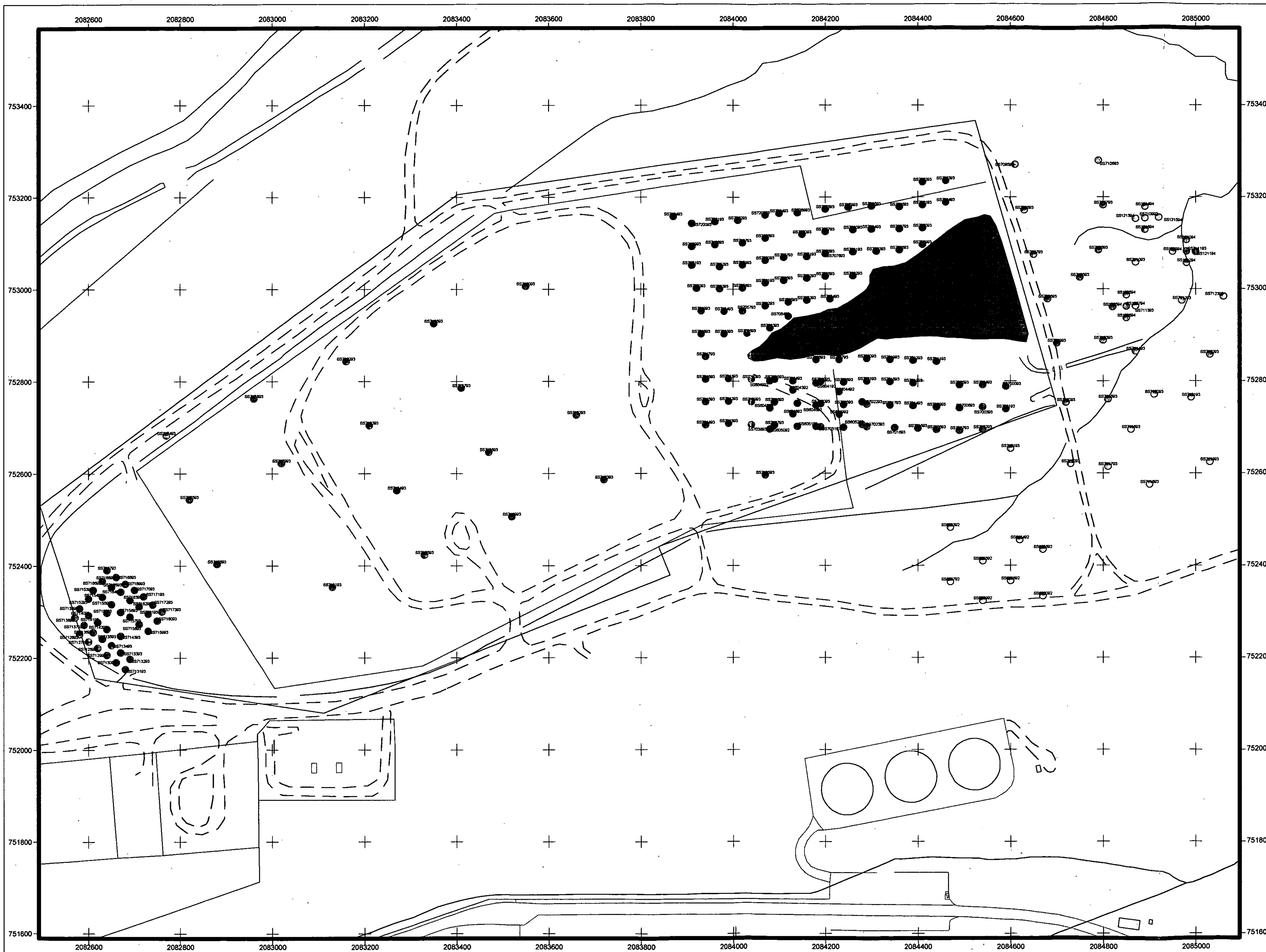


Figure 1
Surface Soil Sampling Locations
Present Landfill

KEY

IHSS 114

Pond

Paved Area

Dirt Road

Stream, ditch, or drainage

Fence

Surface Soil Sampling Location

N

70 0 70 140 210 Feet

Scale = 1:2,500

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

RADMS

Prepared for:

KAISER•HILL COMPANY

w:projects/2003/present landfill/data

March 2004

Appendix F

Applicable or Relevant and Appropriate Requirements

Appendix F – Applicable or Relevant and Appropriate Requirements

Requirement	Citation	Type	Comment
CLEAN AIR ACT (CAA), 42 USC 7401 *et seq.*			
COLORADO AIR QUALITY CONTROL COMMISSION (CAQCC) REGULATIONS	5 CCR 1001 (40 CFR 52, SUBPART G)		
• Emission Control Regulations for Particulates, Smokes, Carbon Monoxide, and Sulfur Oxides	5 CCR 1001-3 (CAQCC Reg. No. 1)		
➢ Smoke and Opacity	Section II.A.1	C	Air pollutant emissions from stationary sources (e.g., fuel-fired pumps, generators, and compressors, process vents/stacks) shall not exceed 20% opacity.
➢ Fugitive Particulate Emissions	Section III.D	A	Technologically feasible and economically reasonable control measures and operating procedures will be employed to reduce, prevent, and control particulate emissions.
▪ Construction Activities	III.D.2(b)		
▪ Storage and Handling of Material	III.D.2(c)		
▪ Haul Roads	III.D.2(e)		
▪ Haul Trucks	III.D.2(f)		
• Air Pollutant Emission Notices (APEN), Construction Permits and Fees, Operating Permits, and Including the Prevention of Significant Deterioration	5 CCR 1001-5 (CAQCC Reg. No. 3)		
➢ APEN Requirements	Part A, Section II	C	An APEN shall be filed with CDPHE prior to construction, modification, or alteration of, or allowing emissions of air pollutants from, any activity. Certain activities are exempted from APEN requirements per specific exemptions listed in the regulation.
➢ Construction Permits, Including Regulations for the Prevention of Significant Deterioration (PDS)	Part B		Construction permits are not required for CERCLA activities; however, substantive requirements that would normally be associated with construction permits will apply.
▪ Construction Permits	Section III	C	Construction permits are not required for CERCLA activities; however, substantive requirements that would normally be associated with construction permits will apply. Also, fuel-fired equipment (e.g., generators, compressors) associated with these activities may require permitting.

A – Action-Specific ARAR; C- Chemical-Specific ARAR; L – Location-Specific ARAR; TBC – To Be Considered

Appendix F – Applicable or Relevant and Appropriate Requirements

Requirement	Citation	Type	Comment
CLEAN AIR ACT (CAA), 42 USC 7401 *et seq.*			
▪ Non-Attainment Area Requirements	Section IV.D.2	A/C/L	Even though CERCLA activities are exempt from construction permit requirements, non-attainment area requirements may apply if emissions of certain pollutants exceed certain threshold limits. The requirements include emissions reductions or offsets, and strict emission control requirements. Although RFETS is no longer a non-attainment area, this requirement is retained in the event the non-attainment designation changes.
▪ Prevention of Significant Deterioration Requirements	Section IV.D.3	A/C/L	Even though CERCLA activities are exempt from construction permit requirements, PSD requirements may apply if emissions of certain pollutants exceed certain threshold limits. The requirements include strict emission control requirements, source impact modeling, and pre-construction and post-construction monitoring.
• Emissions of Volatile Organic Compounds (VOCs)	5 CCR 1001-9 (CAQCC Reg. No. 7)		
• General Requirements for Storage and Transfer of VOCs	Section III.B	A	Applies to the transfer of VOCs to a tank larger than 56 gallons. In such cases, submerged-fill or bottom-fill techniques must be used.
• Disposal of VOCs	Section V	A	Prohibits the disposal of VOCs by evaporation or spillage.
• Storage and Transfer of Petroleum Liquid	Section VI	A	Regulated storage and transfer of petroleum liquids.
• Control of Hazardous Air Pollutants	5 CCR 1001-10 (CAQCC Reg. No. 8), 40 CFR 61, Subpart A		This subpart details the general provisions that apply to sources subject to National Emission Standards for Hazardous Air Pollutants (NESHAPs).
• National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities	5 CCR 1001-10 (CAQCC Reg. No. 8) 40 CFR 61, Subpart H		
➢ Standard	61.92	C/L	This section establishes a radionuclide emission standard equal to those emissions that yield an effective does equivalent (EDE) of 10 mrem/year to any member of the public. The perimeter samplers in the Radioactive Ambient Air Monitoring Program (RAAMP) sampler network are used to verify compliance with the standard.
➢ Emission Monitoring and Test Procedures	61.93	C/A	This section establishes emission monitoring and testing protocols required to measure radionuclide emissions and calculated EDEs. This section also requires that radionuclide emissions measurements (i.e., stack monitoring) be made at all release points that have a potential to discharge radionuclides into the air which could cause an EDE to the most impacted member of the public in excess of 1% of the standard (i.e., 0.1 mrem/year).

A – Action-Specific ARAR; C- Chemical-Specific ARAR; L – Location-Specific ARAR; TBC – To Be Considered

Appendix F – Applicable or Relevant and Appropriate Requirements

Requirement	Citation	Type	Comment
CLEAN AIR ACT (CAA), 42 USC 7401 *et seq.*			
➢ Compliance and Reporting	61.96	C/L	This section requires the Site to perform radionuclide air emission assessments of all new and modified sources. for sources that exceed the 0.1 mrem/year EDE threshold (controlled), the appropriate applications for approval must be submitted to EPA and CDPHE. Additional substantive requirements may apply if the activity requires agency approval.
FEDERAL WATER POLLUTION CONTROL ACT (aka Clean Water Act [CWA]), 33 USC 1251 *et seq.*			
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM REGULATION			
• Storm Water Permit for Construction Activities	40 CFR 122.26	A/L	
• General Permits	40 CFR 122.28	A/L	
• RCRA Subtitle C Hazardous Waste Landfill Effluent Limitations	40 CFR 445.11		Parameters that will be monitored are VOCs and metals. The effluent limits are the surface Water Standards applicable for the receiving water as listed in RFCA Attachment 5, Table 1.
DISCHARGES OF DREDGED OR FILL MATERIAL INTO WATERS OF THE UNITED STATES	33 USC 1344	A/L	
• Discharges Requiring Permits	33 CFR 323.3		
DOE COMPLIANCE WITH FLOODPLAIN/WETLANDS ENVIRONMENTAL REVIEW REQUIREMENTSCOMPLIANCE WITH FLOODPLAIN/WETLANDS ENVIRONMENTAL REVIEW REQUIREMENTS	10 CFR 1022	A/L	
• Floodplain/Wetlands Determination	.11		
• Floodplain/Wetlands Assessment	.12		
• Applicant Responsibilities	.13		

A – Action-Specific ARAR; C- Chemical-Specific ARAR; L – Location-Specific ARAR; TBC – To Be Considered

Appendix F – Applicable or Relevant and Appropriate Requirements

Requirement	Citation	Type	Comment
MIGRATORY BIRD TREATY ACT, 16 USC 701 *et seq.*			
TAKING, POSSESSION, TRANSPORTATION, SALE, PURCHASE, BARTER, EXPORTATION, AND IMPORTATION OF WILDLIFE AND PLANTS	50 CFR 10	A/L	Principally focuses on the taking and possession of birds protected under this regulation. Enforcement is predicated on location of the project and time of the year. Current list of protected birds is maintained by the Site Ecology group.
SOLID WASTE DISPOSAL ACT (aka: Resource Conservation and Recovery Act [RCRA]), 42 USC 6901 *et seq.*; SUBTITLE C: HAZARDOUS WASTE MANAGEMENT (Colorado Hazardous Waste Act [CHWA]), CRS 25-15-101 to -217			
Although the Colorado hazardous waste management regulations are similar to the federal requirements, both the federal and state regulatory citations are provided for reference purposes and to denote that both federal and state requirements were considered in establishing the identifying the ARAR requirement adopted for the remediation of the RFETS. Only substantive portions of the regulations are required under CERCLA actions for onsite activities.			
GENERAL	6CCR 1007-3, Part 261, Subpart A (40 CFR 261, Subpart A)	A	
• Exclusions	.4 (a)(2)		
GENERAL	6CCR 1007-3, Part 265, Subpart A (40 CFR 265, Subpart A)	A	
• Purpose, Scope and Applicability	.1 ©(10)		
CLOSURE	6 CCR 1007-3, Part 265, Subpart G (40CFR 265, Subpart G)	A	
• Closure Performance Standards	.111		The owner/operator must close the facility in a manner that (a) minimizes the need for further maintenance, and (b) controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, haza4rdous constituents, leachate, contaminated runoff, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere.
• Disposal or Decontamination of Equipment, Structures, or Soils	.114	A/C	All hazardous wastes and residues of hazardous waste must be disposed or decontaminated.
• Cover requirements (Landfills)	.310(a)	A/C	Landfills must be closed with a final cover designed and constructed to (1) provide long-term minimization of migration of liquids through the closed landfill; (2) function with minimum maintenance; (3) promote drainage and minimize erosion or abrasion

A – Action-Specific ARAR; C- Chemical-Specific ARAR; L – Location-Specific ARAR; TBC – To Be Considered

Appendix F – Applicable or Relevant and Appropriate Requirements

Requirement	Citation	Type	Comment
SOLID WASTE DISPOSAL ACT (aka: Resource Conservation and Recovery Act [RCRA]), 42 USC 6901 *et seq.*; SUBTITLE C: HAZARDOUS WASTE MANAGEMENT (Colorado Hazardous Waste Act [CHWA]), CRS 25-15-101 to -217			
			of the cover; (4) accommodate settling and subsidence so that the cover's integrity is maintained; and (5) have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.
FEDERAL NOXIOUS WEED ACT (Pub.L. 93-629; 7 USC 2814 *et seq.*)			
MANAGEMENT OF UNDESIRABLE PLANTS ON FEDERAL LANDS	7 USC 2814		
• Duties of Federal Agencies	(a)(3), (a)(4), (c)(1), (c)(2)	A	Federal agencies must complete and implement cooperative agreements with State agencies regarding the management of undesirable plant species on Federal lands under the agency's jurisdiction and establish integrated management systems to control or contain undesirable plant species targeted under cooperative agreements.
COLORADO NOXIOUS WEED ACT (CRS 35-5.5-101 *et seq.*)			
DUTY TO MANAGE NOXIOUS WEEDS	Section 104	A	It is the duty of all persons to use integrated methods to manage noxious weeds if the same are likely to be materially damaging to the land of neighboring landowners, and it is the duty of local governing bodies to assure that these plants are, in fact, managed.
COOPERATION WITH FEDERAL AND STATE AGENCIES	Section 111	A	The local governing bodies in Colorado are authorized to enter into cooperative agreements with federal and state agencies for the integrated management of noxious weeds within their respective territorial jurisdictions. The Jefferson County Noxious Weed Management Plan establishes the countywide strategy for the management, control, and eradication of noxious weeds in the County.

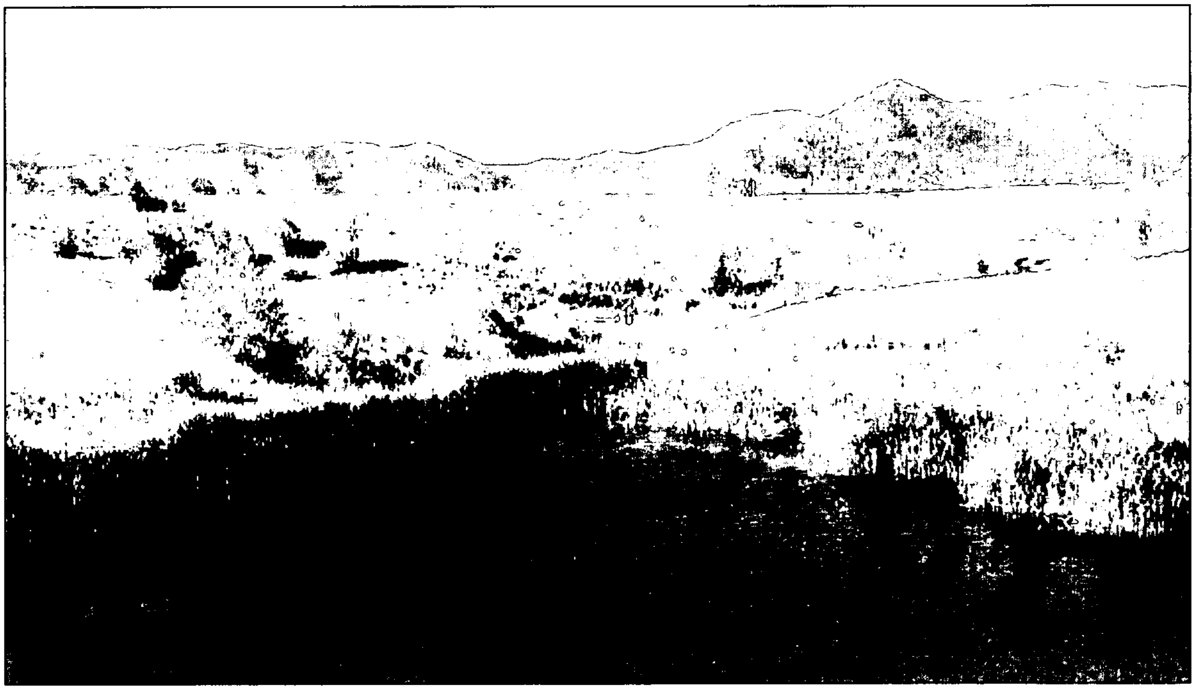
Appendix F – Applicable or Relevant and Appropriate Requirements

Requirement	Citation	Type	Comment
NATIONAL WILDLIFE REFUGE ACT			
NATIONAL WILDLIFE REFUGE SYSTEM ADMINISTRATION ACT	16 USC 668 et seq.	L	Relevant and Appropriate. Prohibits interference with natural growth or wildlife, on National Wildlife Refuges administered by the USFWS, unless permitted.

Appendix G

Wetland Mitigation Plan

Present Landfill Project Wetland Mitigation Plan For The Rocky Flats Environmental Technology Site



MARCH 2004

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Present Landfill Project Wetland Mitigation Plan

Introduction

The Rocky Flats Environmental Technology Site (the Site) is a U.S. Department of Energy (DOE) facility located in rural northern Jefferson County, Colorado, which is approximately 16 miles northwest of Denver. It is approximately 6,200 acres in size. The developed portion of the site, referred to as the Industrial Area (IA), is centrally located within RFETS and occupies approximately 400 acres. The Rocky Flats Buffer Zone surrounds the IA and occupies the remaining 5,800 acres. The Present Landfill (PLF) is located in the RFETS Buffer Zone (BZ), north of the Industrial Area (IA; Figure 1). Closure requirements for the PLF will be met by constructing a cover over the landfill. Construction of the cover will require unavoidable temporary and permanent impacts to wetlands around the East Landfill Pond east of the PLF. The wetland mitigation plan outlines the approach and basic plan that will be taken to mitigate for wetland impacts.

Project Information

Location of Project/Ownership

The PLF area located north of the IA at T2S, R70W, Sec. 2, 3, 10, and 11 (Figure 1). The PLF occupies approximately 20 acres.

Responsible Parties

Joe Legare, Assistant Manager for Environment and Infrastructure
Rocky Flats Environmental Technology Site
U.S. Department of Energy
10808 Hwy. 93
Golden, CO 80403-8200
Ph. 303-966-5918

Bob Davis, Project Manager
Kaiser-Hill Company, L.L.C.
10808 Hwy. 93
Golden, CO 80403-8200
Ph. 303-966-7872

Historical Background of PLF

For historical information on the PLF see the "*Interim Measure/Interim Remedial Action for Operable Unit 7 (IHSS 114) and RCRA Closure of the RFETS Present Landfill*" document (K-H 2004a) of which this wetland mitigation plan is an Appendix.

Ecological Description of PLF Area

General Soils and Vegetation

The overall PLF work area crosses several plant community and soil types. The pediment top surrounding the PLF is composed largely of the Rocky Flats Alluvium. The upper part of the PLF work area is located on this surface. The soil types on this surface are classified as Flatirons very cobbly sandy loam and Nederland very cobbly sandy loam (SCS 1980). The vegetation on this surface is predominantly xeric tallgrass prairie on the western portions of the Site and gradually changes to a needle and threadgrass community as the alluvium thins to the east. Common species on the xeric tallgrass prairie include *Andropogon gerardii*, *Andropogon scoparius*, *Muhlenbergia montana*, *Stipa comata*, *Bouteloua gracilis*, *Bouteloua curtipendula*, *Carex heliophila*, *Poa compressa*, and a variety of other graminoid and forb species. The dominance of these species varies from location to location. The hillsides adjacent to the drainages in the PLF area are dominated largely by the mesic mixed grassland community that is common elsewhere on the hillsides at the Site. Soils on the hillslopes are classified as Denver-Kutch-Midway clay loams (SCS 1980). Common species on the mesic mixed grasslands includes blue grama (*Bouteloua gracilis*), side-oats grama (*Bouteloua curtipendula*), western wheatgrass (*Agropyron smithii*), green needlegrass (*Stipa viridula*), Kentucky bluegrass (*Poa pratensis*), Canada bluegrass (*Poa compressa*), Japanese brome (*Bromus japonicus*), and other forbs and graminoids.

The East Landfill Pond and surrounding wetlands were mapped as jurisdictional wetlands by the U.S. Army Corps of Engineers during 1994 (COE 1994). The pond itself is an open water habitat and is surrounded by emergent wetlands composed largely of cattails (*Tyhpa latifolia*), Torrey's rush (*Juncus torreyii*), and wintercress (*Barbarea orthoceras*). Over the past decade on the northeastern edge of the landfill, enough moisture has been present at or near the ground surface to support the growth of vegetation characteristic of wetter areas. Both coyote willow (*Salix exigua*) and plains cottonwood trees (*Populus deltoides*) can be found in these area. This area runs from the top of the hill in an area where riprap was placed to stabilize the slope, down to the western inlet of the pond.

Fauna

Wildlife use in the PLF work area is comparable to that documented elsewhere on the grasslands and pond areas at the Site (K-H 2001). Common wildlife species that could be encountered include small mammals such as deer mice, prairie voles, meadow voles, and house mice, which provide forage for predators like raptors and coyotes. Common raptors at the Site include red-tailed hawks, Swainson's hawks, great horned owls, and kestrels. Herptiles would be represented by boreal chorus frogs, leopard frogs, and prairie rattlesnakes. Bass have been observed in the pond. A variety of songbirds could be found utilizing the grassland and wetland habitats at different times of the year. Western meadowlarks and vesper sparrows are common inhabitants of the grasslands, red-winged blackbirds, mallards, Canada geese, and other water fowl found occasionally on the pond or in the surrounding wetlands. Mule deer and an occasional white-tailed deer also utilize the habitat in and around the PLF work area.

The Preble's meadow jumping mouse (Preble's mouse; *Zapus hudsonius preblei*), a federally protected, listed threatened species under the Endangered Species Act (ESA) does not occur in the PLF area. Small mammal trapping was conducted in summer 1996 around the inlet of the East Landfill Pond and documented no Preble's mice in the habitat around the pond (K-H 1996). Telemetry work conducted in Walnut Creek during the field season of 1999 also did not document any Preble's mouse movement in the vicinity of the PLF (K-H 2000). The PLF is not located within any of the currently mapped Preble's protection areas at the Site (K-H 2004b).

Hydrology

The Site is located in a temperate and semiarid climate. The atmosphere at the 6,000-foot elevation at the Site is dry and thin, resulting in wide daily and seasonal temperature changes with strong daytime warming and nighttime cooling. The average annual precipitation is 15.5 inches, including rainfall and snowmelt. Nearly 42 percent of the annual precipitation falls in the spring months from April through June. Thirty-six percent of the annual precipitation falls as snow primarily between late October and early April (EG&G 1995). Infiltration of precipitation is the primary source of recharge to the upper hydrostratographic unit (UHSU) materials at the Site. Most precipitation, however, is lost to runoff and evapotranspiration.

The East Landfill Pond was constructed in 1974. The East Landfill Pond covers approximately 2.5 acres and has a capacity of approximately 7.5 million gallons. Pond water levels are controlled to prevent overflow into the spillway draining to No Name Gulch. Sediments have been accumulating in the East Landfill Pond since its construction in 1974. The sources of contaminant loading to the pond sediments include leachate and surface water run-off from surrounding slopes. Results from sampling events performed during the Phase I RFI/RI indicate the sediments consist of clay, silt, and organic matter, ranging from 0.5 to 0.8 feet thick. The upper 0.2 to 0.5 feet of sediments consist of black silt and clay, with very fine roots occurring in either thin mats or scattered throughout the core. No bedding or lamination was visible. The remaining 0.3 to 0.4 feet of core consisted of very dark gray clay with some silt. Very fine roots were observed, decreasing with depth. The pond sediments are underlain by olive-gray claystone of the Laramie Formation.

The Rocky Flats Alluvium is 25 to 30 feet thick on the northwest, west, and southwest sides of the landfill, and 10 to 15 feet thick on the divides north and south of the East Landfill Pond. Colluvium is one to five feet thick on the slopes around the pond and below the dam. The valley-fill alluvium ranges in thickness from three to eight feet in the landfill area and becomes thicker downstream to the east. The thickness of artificial fill increases from about five feet at the perimeter of the landfill to about 45 feet near the centerline of the valley. Weathered bedrock material thicknesses vary considerably in the vicinity of the landfill, ranging from approximately four to 35 feet.

Average depth to groundwater ranges from five to 15 feet in surficial deposits, excluding artificial fill. Within the PLF, groundwater is found at approximately 20 feet at the western end, 16 feet in the middle, and 33 feet at the eastern end. The depth to groundwater in weathered bedrock is generally greater than that of the overlying surficial deposits due to steep downward vertical gradients in bedrock materials.

A passive seep collection and treatment system currently exists just west of the East Landfill Pond near eastern edge of the current landfill extent. This system will be engineered to continue to collect and treat any water that does flow from the landfill.

Existing Functions and Values

The function and value of the wetlands within the PLF work area provide several functions including water quality enhancement, filtering or trapping of sediment, nutrients, and toxic compounds, ground water recharge and discharge, minor flood conveyance and attenuation, and providing habitat for many plant and animal species at the Site.

Buffers

The areas surrounding the PLF work area and the wetlands within the work area are part of the Buffer Zone. The shooting range is located to the west of the PLF. On the north, the McKay Ditch runs southwest to northeast across the Site. To the east and northeast there is mostly native xeric and mesic mixed grassland. Directly to the south is an electrical substation and beyond that Walnut Creek and then the IA.

Project Approach

The PLF is being addressed as an accelerated action under RFCA, which provides for the coordination of DOE's response obligations under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and its closure and corrective action obligations under RCRA and CHWA. Closure requirements for the PLF are contained in Attachment 10 to RFCA, which specifies that the landfill must be closed in place with an engineered cover system designed to:

- Protect the most directly impacted surface water, and
- Control any remaining sources of groundwater contamination to the extent necessary to prevent enlarging the plume or increasing contaminant concentrations.

Engineered covers are the presumptive remedy for CERCLA municipal landfill sites (EPA 1993). Such containment technologies are generally appropriate for municipal landfills because the waste poses a relatively low long-term threat to public health and the environment, and the volume and heterogeneity of the waste make treatment impractical. Although the majority of waste disposed in the PLF is considered municipal waste, some hazardous wastes were buried there and hazardous components have been detected in the leachate. An engineered cover will be used on the PLF.

The conceptual design proposes a minimum thickness of 24 inches of topsoil, a 12 inch cobble surface, a 6 inch soil cushion layer, underlain by a drainage net, non-permeable plastic sheeting, and sandwich of bentonite between two layers of geotextile.

Original planning indicated that the East Landfill Pond and associated wetlands would be destroyed and covered by the cap. However, in order to minimize impacts to the wetlands, the cover has been redesigned so it will not completely destroy the pond and wetland areas. However, approximately 0.01 acres of wetland will be lost permanently under the cover. The current wetland vegetation in the area that will be permanently lost consists predominantly of cattails and coyote willow. And during construction activities necessary to construct the east slope of the cover, some temporary impacts will also occur in the westernmost portions of the pond and wetlands (Figure 2). A total of 0.11 acres of the pond and wetlands may be filled temporarily or impacted to allow construction equipment access for construction of the east slope of the cover. Once construction activities are concluded, the fill material will be removed and the pond edge and wetlands will be re-established. The seep collection and treatment system will be modified and updated, but will occur in the same location as it currently exists, so no change in its footprint is expected. The wetland should re-establish around it as it currently exists.

Impacted Wetland Area Descriptions

Based on the 1994 U.S. Corps of Engineers wetland report for the Site (COE 1994), approximately 0.12 acres of jurisdictional wetlands will be disturbed by the cleanup and construction activities. Table 1 lists the wetland types and acreages that will be impacted. Figure 2 shows the locations of these areas.

Table 1. Wetland Impacts

Wetland Type	Acreage
Permanent Loss	
Impoundment; palustrine emergent, saturated	0.01
Sub-total	0.01
Temporary Loss	
Open water; lacustrine limnetic, unconsolidated bottom, permanently flooded	0.08
Impoundment; palustrine emergent, saturated	0.03
Sub-total	0.11
Grand total	0.12

Approximately two-thirds of the impacted wetland area to be disturbed in the East Landfill Pond is mapped as open water habitat. The remainder of the wetland areas impacted are palustrine emergent wetland areas dominated by cattails, Torrey's rush, and wintercress. During 2003, however, there was no open water habitat in the area to be disturbed. Cattails extended across the pond bottom in the area to be disturbed with some coyote willow around the wetland boundary. The wetland area of permanent loss is predominantly cattails and coyote willow.

Mitigation Approach

A plan to mitigate wetland impacts has been developed to offset the wetland losses resulting from the PLF project. The typical approach to wetland issues is to 1) avoid impacts, 2) minimize impacts that are unavoidable, and 3) mitigate for unavoidable impacts. The PLF project is a required cleanup and remediation action under RFCA. Total avoidance of impacts to the East Landfill Pond and associated wetlands is not feasible due to the cleanup requirements and the need for a landfill cover. The permanent wetland losses (0.01 acres) will be mitigated through the use or purchase of wetland banking credits. Temporary impacts will be mitigated in-situ once construction activities are concluded. The fill material will be removed and the pond edge and wetlands in the temporarily impacted areas will be re-established. NOTE: The actual number of acres of wetland disturbed will be mitigated should the actual amount of disturbance be different from that described.

Mitigation Goals and Objectives

1. Goal #1: Mitigate temporary PLF wetland impacts in-situ through the re-establishment of 0.11 acres of emergent wetland habitat (mitigation ratio = 1:1).

2. Goal #2: Mitigate PLF permanent wetland impacts through the use or purchase of wetland mitigation bank credits (mitigation ratio = 1:1). The total wetland acreage permanently lost beneath the landfill cover will be 0.01 acres.

Performance Objectives (Success Criteria)

These performance objectives are specific to the PLF project.

Goal #1 - Vegetation Structure
Objective a. The PLF will re-establish 0.11 acres total of emergent wetland habitat.

Performance Standard #1: The area of emergent wetland will be 0.11 acres after 5 years and the total vegetation cover will be 70% (live and litter). Native species relative foliar cover will be at least 70%. Noxious weeds (as defined by the current Colorado Noxious Weed Act) will be managed during the 5 year establishment period to comprise no more than 5% relative cover at the in-situ mitigation area.

Rationale for Choice

Reconstruction of the PLF wetland area in the pond for temporary impacts is the preferred choice to mitigation off-site because of the available water in the pond and the passive seep collection and treatment system that will still be in place on the east side of the cover. These factors make it feasible to re-establish the wetlands that will be impacted at the PLF.

For mitigation of permanent wetland losses, in-situ wetland replacement on-site is not feasible because the original wetlands will be under the cover. Expansion of the pond is not practical because of the cover design north and south of the pond. Additionally, expansion of the pond is not desired and would destroy the wetlands currently there to make them larger. Therefore, a mitigation banking option will be used to offset these wetland losses.

Mitigation Bank Approach

The first mitigation bank option will use the DOE's Standley Lake wetland mitigation bank for credits to offset permanent wetland losses in the PLF area. This bank was constructed several years ago by the DOE for use to offset wetland damages at Rocky Flats. At the time of writing, however, the Standley Lake bank had not been certified officially by the EPA although it is expected that this certification will occur soon. If the Standley Lake wetland bank credits cannot be applied to the PLF, however, then purchase of wetland bank credits from an off-site wetland mitigation bank will be necessary. A mitigation ratio of 1:1 will be used for use or purchase of wetland bank credits from either bank. Two potential commercial wetland mitigation banks that are present along the Front Range of Colorado are listed below.

Potential Off-Site Commercial Wetland Mitigation Banks

Middle South Platte River Wetland Mitigation Bank, Erie, CO
Banker: Land and Water Resources, Inc., 9575 W. Higgins Rd., Suite 470, Rosemont, IL 60018
John Ryan, Ph. 708-878-3903
Mitigation credits were still available as of June 2002. Cost: 60K to 80K+ per acre, variable depending on number of acres purchased.

Mile High Wetland Bank, Brighton, CO
Banker: Mile High Wetland Group, LLC, 80 South 27th Ave., Brighton, CO 80601
Laurie Rink, Ph. 303-659-7002
Mitigation credits are available as of July 2002. Cost: $80,000 per acre, with some decrease for volume purchases.

The wetland acres disturbed (debits) will be tracked in the Site's wetland debit/credit spreadsheet. The re-establishment of the wetlands around the pond and/or the use of any wetland mitigation banking credits will also be tracked in the spreadsheet.

Ecological Description of PLF In-Situ Wetland Mitigation Site

General ecology information of the impact or mitigation site has been described previously (mitigation will occur at the impact site after completion of remediation activities). Additional information for the PLF is provided below.

Present and Proposed Uses of Mitigation Area

Currently the wetlands in the PLF are part of the Site's Buffer Zone. The Buffer Zone is a large area of land surrounding the IA which serves as a security zone and potential contaminant release buffer from the general public. Public access is not permitted and only authorized Site personnel are allowed in the Buffer Zone. As a result, the wetlands around the East Landfill Pond have developed with little influence from human influence for many years.

After Site closure and cleanup, the majority of the Site will be transferred to the USFWS for the anticipated future use as a National Wildlife Refuge. However, the PLF and pond will remain under control of DOE and will not be transferred to the USFWS.

Present and Proposed Uses of Adjacent Areas

The areas east, west, and north of the PLF currently are part of the Buffer Zone. To the south of the mitigation area is the IA which is currently being cleaned up, torn down, and revegetated to native grassland. Areas beyond the boundary of the Site itself include largely Open Space to the west, north, and east, with private rangeland to the south. At some off-site locations on the west and east, minor incursions of development have taken place.

Noxious weeds

Noxious weeds will be controlled in the PLF after remediation is completed through the use of an integrated weed management program that may include the use of administrative, cultural, mechanical, biological, and/or chemical methods. Noxious weed species that are common in the PLF area include, Canada thistle (*Cirsium arvense*), diffuse knapweed (*Centaurea diffusa*), musk thistle (*Carduus nutans*), and common mullein (*Verbascum thapsus*).

Hydrology

The hydrology of the PLF was discussed earlier in the report.

Reconstruction Benefits

The benefits of replacing the destroyed wetlands in-situ in the PLF area are several.

- The wetland reconstruction will re-establish western edge of the East Landfill Pond as much as is feasible given the design constraints of the cover.
- Replacement and management of the restoration of wetland habitat around the East Landfill Pond and native grassland habitat on the hillside area on the cover will improve and enhance the natural values of the area and improve wildlife habitat.
- Reconstruction of the wetlands in-situ will replace and restore the functional values of the wetlands around the East Landfill Pond that would otherwise be lost.

Constraints

- The source of water for the East Landfill Pond is from groundwater, precipitation events, and the seep west of the pond. Drought years could affect establishment and sustainability of wetland and riparian vegetation.
- The local deer population might potentially browse any woody plantings and decrease the probability of success of the wetland reconstruction.

Preliminary PLF Wetland In-Situ Mitigation Site Plan

A preliminary site plan for the wetland reconstruction in the PLF is presented below. Construction activities for the eastern area of the PLF landfill cover will require that the 0.12 acres of the western portion of the East Landfill Pond and associated wetlands be permanently or temporarily impacted during construction activities. A total of 0.11 acres may be filled temporarily or disturbed to allow construction equipment access for construction of the east slope of the cover.

The objective of the plan is to recreate 0.11 acres of emergent wetland. Currently most of the western edge of the pond is dominated by cattails with some coyote willow around the edges. A migitation ratio of 1:1 will be used in the PLF to replace the destroyed wetlands. A key component of wetland reconstruction design is hydrology. Because the area to be re-established is part of the East Landfill Pond, water is available for re-establishment by simply adjusting the height of water in the pond. Water height can be fluctuated to allow development of the wetland plant community.

Once construction activities on the cover are complete, if fill material was placed in the wetlands, it will be removed and the contours of the pond bottom re-established. Fill material will be removed down to the level of the original pond bottom. The buried cattails and original pond sediment material will be the line to which dredging will occur.

Native plant species will be used to reestablish the native wetland types present. Native plants will be reestablished by seeding. Table 2 lists the species of plants which may be used to re-establish the wetland. Weed control will be used to reduce competition for the native species and provide a more native plant community in the end. Although the native species listed below will be seeded, it is likely the area will be dominated in time by cattails again, because the root systems of the cattails will probably survive temporary burial and the remainder of the edge of the landfill pond is mostly cattails.

Table 2. Native Plant Species

Common Name	Scientific Name
Coyote willow	*Salix exigua*
Great bulrush	*Scirpus validus*
Greenscale bulrush	*Scirpus pallidus*
Nebraska sedge	*Carex nebrascensis*
Prairie cordgrass	*Spartina pectinata*
Pungent bulrush or Three-square	*Scirpus pungens* (*Scirpus americanus*)

Monitoring Plan

Monitoring of selected factors will be conducted to assess whether performance standards for vegetation, habitat attributes, and hydrology are being met. A monitoring plan will be developed based on final design parameters that outlines and contains the following information:

- the questions under investigation,

- variables to be measured,
- sampling methods to be used for each variable,
- sampling schedule,
- sample locations,
- who will be conducting the monitoring, and
- a reporting schedule.

Management Plan

A management plan will be developed to described planned maintenance for the PLF wetland mitigation, including potential maintenance schedules. Suggested items to include in the management plan are: the inspection of water structures and water monitoring devices, monitoring information, plant replacement, weed control, fertilization, erosion control, herbivore protection, and trash removal. The plan will also identify the entities responsible for financing and carrying out the maintenance activities.

Contingency Measures

Responsibility for management, maintenance, and monitoring of the PLF wetland mitigation will be conducted by DOE or their designee. If vegetation development does not occur as planned, corrective measures will be employed. This could include reseeding, weed control, mulching, fertilization, and other measures. Additional seeding will be conducted within the year, if problems with wetland vegetation establishment are observed. Assessment and recommendations for corrective measure will be performed by a qualified botanist/plant ecologist or wetlands expert.

Monitoring of selected parameters may be continued if performance standards are not met within the 5 year period.

Project Funding

Funding for the project is being provided by the DOE as part of the Site cleanup and closure activities that are being directed and overseen by Kaiser-Hill Company, L.L.C.

Site Protection

The PLF wetland mitigation area is protected by the DOE as part of the Site Buffer Zone. Management restrictions currently limit activities in the PLF and this will continue through Site closure. Post-closure it will be managed and protected in perpetuity by DOE/USFWS to promote and preserve the ecological resources and values at the Site.

References

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EPA, 1993, Presumptive Remedy for CERCLA Municipal Landfill Sites, EPA 540-F-93-035, Directive No. 9355.0-49FS, U. S. Environmental Protection Agency, September 1993.

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K-H. 2001. 2000 Annual Wildlife Report for Rocky Flats Environmental Technology Site. Prepared by Exponent for Kaiser-Hill Company, LLC. Rocky Flats Environmental Technology Site, Golden, CO.

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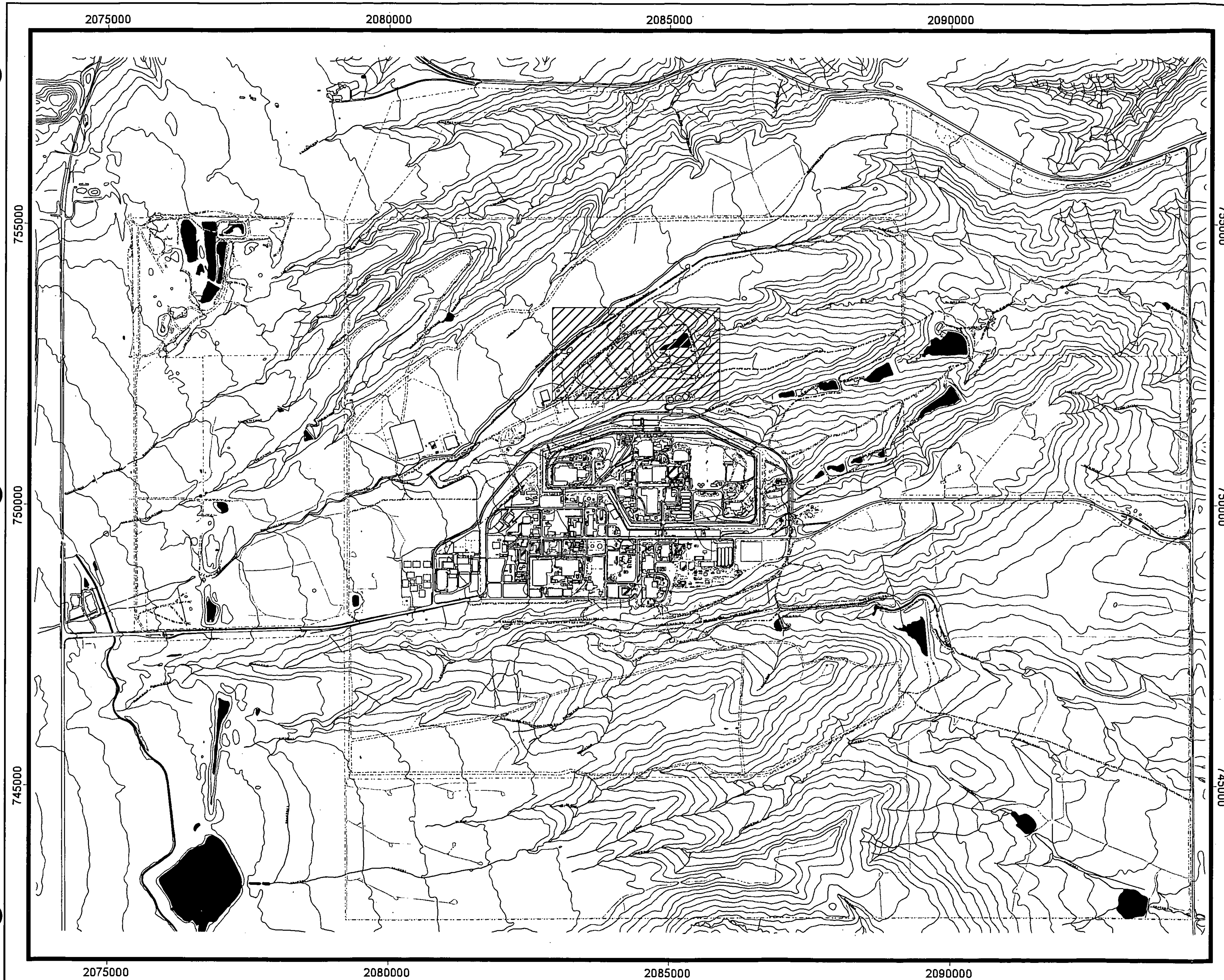
K-H. 2004b. Preble's Meadow Jumping Mouse Protection Plan, Programmatic Biological Assessment, Part I, Appendix A, U.S. Department of Energy, Rocky Flats Field Office. Kaiser-Hill Company, LLC. Rocky Flats Environmental Technology Site, Golden, CO.

SCS. 1980. Soil Survey of Golden Area, Colorado. U.S. Department of Agriculture, Soil Conservation Service, Washington, DC.



Current Landfill Project General Location

Figure 1

LEGEND

General Project Area

Standard Features

- Buildings
- Demolished Buildings
- Lakes & ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95.

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1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: LABAT-ANDERSON INCORPORATED

For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 03-0002

October 17, 2002

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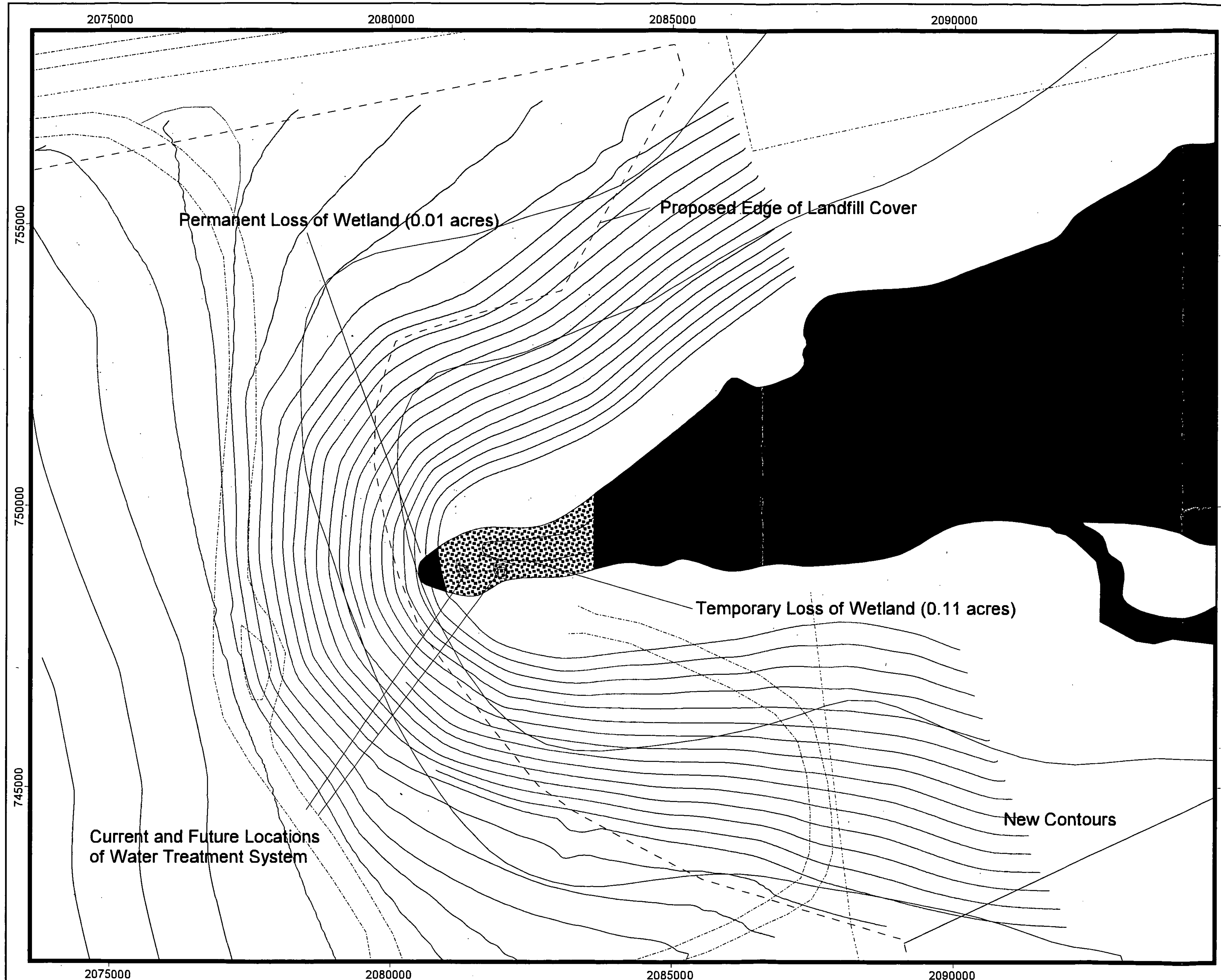

Present Landfill Project Wetland Impacts

Figure 2

- Temporary Disturbance L1UBH (Lacustrine limnetic, unconsolidated bottom, permanently flooded)
- Temporary Disturbance PEMB (Palustrine emergent, saturated)
- Permenent Loss PEMB (Palustrine emergent, saturated)
- L1UBH (Lacustrine limnetic, unconsolidated bottom, permanently flooded)
- PEMB (Palustrine emergent, saturated)
- PEMB (Palustrine emergent, seasonally flooded)
- PEMB (Palustrine emergent, temporarily flooded)

Standard Features

- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95.

N

50 0 50 100 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Professional Environmental Group, L.L.C.

For: Kaiser-Hill Company, LLC

RFETS GIS Dept.
303-966-7707

MAP ID: 04-0013

January 21, 2004

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Appendix H

Responsiveness Summary

Rocky Flats Coalition of Local Government Comments
Draft Interim Measure/Interim Remedial Action (IM/IRA)
for Operable Unit 7 (IHSS 114) and RCRA Closure of the RFETS Present Landfill

Comment No. (Ref)	Comment	Response
1	Provide a clearer and more substantive basis for why the proposed cover is preferable to an ET cover.	Long term maintenance will be required on both the proposed cover and an ET cover. The evaluation of the cover alternatives considers the overall short-term and long term impacts of action and considers that the long term maintenance requirements of the proposed action are generally less than the short term negative impacts of the ET cover.
2	The document must be much more definitive in identifying the specific performance criteria for the cover which will indicate whether there are any performance problems that necessitate a corrective action.	The proposed action is a presumptive remedy for containment for landfills under the RCRA guidance and does not require specific performance monitoring requirements.
	Proposed Cover versus ET Cover	
3	It is unclear the extent to which stewardship factored into the remedy selection process. The depth of such analysis in the Alternatives Analysis is lacking, and the document thus does not present a strong argument as to why the proposed cover is preferable to the ET cover over the long-term.	Long term maintenance will be required on both the proposed cover and an ET cover. The evaluation of the cover alternatives considers the overall short-term and long term impacts of action and considers that the long term maintenance requirements of the proposed action are generally less than the short term negative impacts of the ET cover.
4	The Alternatives Analysis clearly states that the ET cover will have low long-term costs because it will require very little maintenance over the long term and will be inexpensive to repair. The proposed cover, in contrast, will cost much more over the long-term, as repairs will require "extensive excavation and complex repair procedures". This assertion, which Kaiser-Hill also touted in 2002, matches research conducted by Dr. Steven Dwyer, a researcher at the Sandia National Laboratory, who concluded from his study that geosynthetic liners can desiccate and crack in arid environments. This issue is important because of the potential for desiccation and differential settling in the future, which could necessitate repairs to the cover.	Clay covers that are RCRA compliant can be subject to desiccation; however the proposed cover using the geosynthetic components is not subject to desiccation. Repair of the proposed cover is not likely since the differential settlement of the landfill is not considered to be extensive. An analysis of differential settling will be conducted as a part of the detailed design and will be used to select and specify the materials of construction for the goesynthetic cover.
5	Conversely, the IM/IRA states that building an ET cover presents a much higher short-term risk than the proposed cover due to the high volume of trucks required to import the soil to build an ET cover. The document thus concludes that the proposed cover is the best remedy for the Present Landfill based on the	Section 4.0 of the IM/IRA specifically discusses and calculates the additional safety risks associated with the construction of an ET cover. Clearly, the additional vehicle-miles required to build the ET cover and the associated accident rates is less for the proposed geosynthetic cover alternative that uses more common materials

	short-term risks, as the two covers are equal in terms of remedy effectiveness and estimated capital cost. What is unclear from the document is whether an analysis was ever conducted that fully weighs the short-term risks of installing an ET cover versus the long-term cost and maintenance of the proposed cover. This type of analysis – the consideration of stewardship as a key component of the remedy selection process, and not simply after a remedy has been chosen – is one for which the Coalition has pushed time and time again. In the absence of such an analysis, the Board is struggling to understand the basis for why the proposed cover is preferable to the ET cover.	located closer to the RFTES facility.
	Monitoring of the Landfill Seep	
	In addition to this overlying stewardship concern regarding the Alternatives Analysis, we also raise the following issues which go to the technical details of a long-term stewardship analysis. These issues include: monitoring of the landfill seep, groundwater monitoring, cover performance, regulatory compliance, and effects of weed control on surface water. Monitoring the landfill seep is obviously of great importance as it will be a key indicator of the effectiveness of the proposed cover. As we note below, two major uncertainties remain with the seep: the source of the seep and the effects of the cover on the seep. We believe the proposed monitoring of the seep should be more comprehensive and cover a longer timeframe, both of which will help address these uncertainties and reduce the potential for problems in the future.	Appendix A discusses the monitoring requirements for the seep. The text states that during the CERCLA periodic review, the RFCA Parties will evaluate whether continued monitoring is required after a proposed sampling period. The time frame itself does not mean that sampling could discontinue automatically. The evaluation will include a thorough data analysis. The text of the IM/IRA (See Appendix A) will be modified to present that seep monitoring will occur quarterly. The RFCA parties can adjust the frequency of sampling; however, based on the regulations, the monitoring frequency will be at least annually.
	The first uncertainty associated with the seep is that its source remains unclear. The 1996 IM/IRA for OU7 concluded that 40% of the seep was from ground water and the remaining 60% from infiltration. This determination is obviously in sharp contrast to the current assumption that 90% of the seep results from infiltration and 10% from groundwater. The source of the seep is important because the Present Landfill remedy must significantly reduce the amount of water that percolates into the Landfill waste. If most of the water in the waste is from infiltration, the remedy as proposed should achieve this design goal. If a significant portion of the water in the waste is coming from groundwater, the remedy as proposed may not be sufficient.	The discrepancy between results of the current modeling and former modeling regarding the ratio of infiltration to lateral groundwater inflow is due to significant differences between the two models. These differences are highlighted below: Former Model: a) Modflow groundwater flow model. b) Boundary conditions: - lateral conditions (constant head, general head) - recharge – calibration parameter (estimated) - evapotranspiration – apparently not considered - seepage – drain/constant head - Pond – constant head c) Steady state model (10000 yr transient model with no time-varying stresses, or boundary conditions), d) Grid resolution 50 feet by 50 feet

		e) Model Area (smaller than current model to the west, north and south) f) Vertical model layers (2 layers - 1 for alluvium and 1 for weathered bedrock) g) Top and bottom of weathered bedrock surface – GIS data available at the time (pre-1995) h) GWIS system – simulated as a drain i) Trench clay barrier – apparently not considered j) Internal Trench collection trench (gravel layer, 5' thick at base of trench) – apparently not considered? k) Calibration to only average annual groundwater heads and seep discharge. Difficulty with bedrock wells. Current Model: a) Integrated flow model simulates the dynamic coupling of overland flow, unsaturated zone and saturated zones. b) Boundary Conditions - Utilized actual time-varying climate data; 15-minute precipitation, temperature, and hourly potential evapotranspiration based on time-varying wind speed, humidity, solar radiation and temperature. - Included effects of snowmelt and subsequent runoff - Included effects of spatially and temporally varying annual vegetation dynamics on unsaturated zone behavior – i.e., calculated actual evaptranspiration, soil evaporation and transpiration, - Spatial and temporal variability of recharge to groundwater is calculated in this model based on climate variability and unsaturated zone dynamics, including evapotranspiration. This is a complex boundary condition. c) Transient integrated model – Used actual time-varying climate information at the precipitation event-level. d) Grid resolution 50 feet by 50 feet e) Model Area (larger than former modflow model on the north, south and west sides) to reduce boundary effects on internal calculations. Also considered more realistic surface and subsurface boundary conditions than former model (i.e., typically groundwater divides) f) Four saturated zone layers. This accounted for waste material, unconsolidated material beneath waste and beneath landfill trench, and for weathered bedrock. g) GWIS drain, clay barrier and internal gravel drain were all simulated in the integrated model explicitly. h) A considerable effort was made to obtain all available information on the weathered bedrock surface. The GIS database used to define this surface and

	the bottom of the weathered bedrock represent the most comprehensive to date. This is a key surface in the modeling. i) Calibration to: • Seasonal heads, • Average annual heads (unconsolidated and bedrock) • Seep discharge, • Qualitatively – overland flow (minimal) The integrated model accounts for more hydraulic features, has more model layers, and more correctly simulates actual integrated system processes than the former modflow-groundwater model. Model results from former modflow modeling did not include ET, the largest discharge component of the water balance in the area. Including ET in the current model results in more reliable model. In the former modflow model, spatially uniform and temporally constant recharge rates are assumed, rather than calculated as in the integrated model. Despite the range of hydraulic conductivity values for unconsolidated material at RFETS, these values were held constant during calibration, while recharge was adjusted to match observed annual average heads (unknown how this is averaged). No effort was made to estimate recharge rates that would be obtained if hydraulic conductivity values in the model had been adjusted, even slightly. It is well known that varying recharge and hydraulic conductivity lead to non-unique model solutions. In otherwords, if recharge is increased, hydraulic conductivities could also be increased such that heads are still matched. Therefore, the total recharge could be several times higher (or lower) than actual rates, depending on what hydraulic conductivity values are used, and the heads could be matched equally well. As a result, there is no basis for concluding that calibrated 'recharge' values are obtained in the former Modflow modeling. Moreover, by not having simulated unconsolidated material (including waste) with at least two layers in the former modeling, it is not possible to simulate lateral groundwater flow accurately within the unconsolidated material beneath the waste, or beneath the northern side of the landfill trench where the recent modeling work more accurately estimates interpolated weathered bedrock depths (i.e., more data). Finally, not explicitly simulating the internal landfill drain, or the clay barrier severely limits the ability of the former model to evaluate groundwater response anywhere near the landfill trench system (especially in light of the lack of ET, and poor calibration of recharge and hydraulic conductivities). The former model is

		therefore, unable to accurately or realistically predict groundwater performance within, or external to the waste area, for current, or future cover conditions. Because the former model simulates a single drain that allows inflow from the waste and groundwater external to the trench, the amount of recharge is likely overestimated within the waste area to produce observed seep discharge. In other words, the drain pulls groundwater from the waste side, that would have eventually discharged to the seep as the current integrate model predicts. Ultimately, this makes the entire water balance in the former modflow modeling (especially in terms of estimating the ratio of recharge to lateral groundwater inflow) inaccurate, unrealistic and unreliable. The former modeling report also suggests the trench on the north side and possibly south side is breached. However, this is assumed based on similar groundwater levels. This assumption is however, not valid, as it is possible that similar heads may occur due to similar recharge rates. A breach could only be confirmed through hydraulic testing, tracer testing, or through geochemical fingerprinting. None of these were performed and the concept of a breach, consequently remains only an assumption.
	We know that installing a cover will add a significant amount of weight to the Present Landfill, which could potentially change the hydraulic regime in the area. Such a change could affect the mobility of contaminants in the subsurface over time and thus the composition of the seep.	It is valid to assume that little change would occur by adding a cover to the waste material given waste emplacement techniques (i.e. in lifts every day, with compaction). The modeling report summarized water level response from wells within the waste over several years. Compared to seasonal water level fluctuations observed external to the waste area, levels are relatively constant in time.
	To address these two uncertainties, the Board recommends longer and more comprehensive sampling. The current language in the IM/IRA states that the RFCA parties will evaluate whether continued monitoring of the seep is required after four years, and that any monitoring beyond that time would *de facto* require the affirmative agreement of the RFCA parties. The Board believes this presumption in favor of stopping monitoring is flawed, since all parties would need to agree on the need to continue monitoring. One party could therefore unilaterally decide that monitoring should cease, thereby vesting too much authority in that party. The Board believes the IM/IRA should instead provide that monitoring of the seep should continue until such time that the RFCA parties agree that it is no longer necessary, addressing the above concern.	Appendix A describes the monitoring requirements for the seep. The text states that during the CERCLA periodic review, the RFCA Parties will evaluate whether continued monitoring is required after a proposed sampling period. The time frame itself does not mean that sampling could discontinue automatically. The evaluation will include a thorough data analysis. The text of the IM/IRA (See Appendix A) will be modified to present that seep monitoring will occur quarterly. The RFCA parties can adjust the frequency of sampling; however, based on the regulations, the monitoring frequency will be at least annually.
0	We recommend annual sampling for a comprehensive suite of analytes after	The landfill has been in existence for 35 years and 15 years of seep monitoring has

	installation of the cover until the effects of installing the cover are better understood. Given how slowly groundwater moves, we believe enough time must be allowed to accurately gauge whether any changes in the seep composition have occurred.	occurred. Sampling and analysis of the seep water has historically included metals (dissolved and total), Contract Laboratory Program (CLP) Volatile Organic Compounds (VOCs), CLP Semi-volatile Organic Compounds (SVOCs), CLP pesticides, radionuclides and water quality parameters. With the passage of a significant amount of time, only a few VOCs have been identified to be present in the Present Landfill seep water. RFCA parties determined, based on historical monitoring data for the seep, that good indicator parameters for changes in the seep water quality are VOCs and metals. If analysis indicates a statistically significant change in these indicator parameters are present in the Present Landfill seep, additional analytes may be added.
	Groundwater Monitoring	
	The IM/IRA states that groundwater sampling will be conducted for two years after the cover is installed, after which the RFCA parties will determine whether any further groundwater monitoring is required. Please provide the basis for choosing two years as the time period for monitoring, rather than the 30 years that is generally required under RCRA.	The landfill has been in existence for 35 years, groundwater monitoring has been ongoing for 30 years and RCRA groundwater monitoring has been ongoing for 17 years (A summary is provided in Appendix B). Historical groundwater monitoring data indicate there is not a significant impact to downgradient groundwater quality resulting from the Present Landfill. The conceptual flow model as discussed in section 2.5.7.1 supports these analytical results. The flow model indicates that all saturated zone flow upgradient of the Present Landfill seep is conceptualized as discharging at the surface at, or immediately downgradient of, the Present Landfill seep (the Present Landfill Pond) The post-accelerated action period for the Present Landfill will be identified initially as 30 years, recognizing that the regulatory agency may shorten this period, if a reduced period is sufficient to protect human health and the environment. This evaluation will be conducted during the CERCLA periodic review period.
	Cover Performance	
2	As with any remedial action, data quality objectives must be developed to know whether the remedy is performing as designed. An evaluation of the data indicates whether any corrective action is necessary. The Board believes that the IM/IRA should better identify specific performance criteria that indicate whether or not the cover is working.	The closure performance standards for the Present Landfill are RCRA interim status closure performance standards and have been identified as ARARs in Appendix F and are discussed in Section 6.1. In addition, RCRA interim status closure specifies unit specific closure standards for a landfill including the design and construction requirements for installing a Subtitle C cover [265.310(a) also identified as an ARAR in Appendix F]. A subtitle C cover is designed to minimize infiltration through the cover, promote drainage, function with minimal maintenance, accommodate settling and have a permeability less than the existing subsoils present beneath the landfill. As specified within these regulatory requirements, compliance with RCRA Subtitle C design standards ensures that a

		facility is closed in a manner that is protective of human health and the environment. As a result, additional performance monitoring of a RCRA Subtitle C cover is not required. Maintaining the integrity of the cover is discussed in the IM/IRA. In addition, under the CERCLA process, a cover over a landfill is considered a presumptive remedy, in that it is presumptively the most appropriate based on historical patterns of remedy selection and on EPA's scientific and engineering evaluation of performance data on implementing such a cover over a landfill.
	Regulatory Compliance	
3	Section 4.2 (Seep Alternatives) states that "The alternatives have been developed assuming that the passive seep interception and treatment system meets the RCRA WWTU exclusion and the substantive requirements of NPDES permit." What are the potential repercussions if this assumption proves wrong? When will this assumption become a known?	As discussed in section 6.4.3. and as confirmed by John Watson of Moye/Giles Attoneys at Law (letter [attached] dated October 17, 2003 from John L. Watson of Moye Giles LLP to Jerry Henderson, RFCAB), the passive seep interception and treatment system does meet the RCRA WWTU exclusion. Clarification to the referenced sentence has been changed to "The alternatives have been developed based on the determination that the passive seep interception and treatment system meet the RCRA WWTU exclusion and the substantive requirements of NPDES permit."
	Effects of Weed Control on Surface Water	
4	Section 6.1.1 (Minimize the Need for Further Maintenance) states that "... vegetation and weed control measures will be employed...." What measures will be used? If herbicides are applied, what is the potential threat to the Landfill Pond and No Name Gulch? Will DOE sample for toxic constituents contained in the chemicals?	The proposed cover configuration has been modified above the geosynthetic liner to provide a vegetative cover (See attached cover cross-section). This revised cover configuration will required some weed control until native vegetation is fully established. Appendix A identifies the engineered controls, including weed control, inspection and reporting requirements and frequencies, which will be implemented for the proposed action. Details of weed control (if required) will be included in the Maintenance and Monitoring Plan. The DOE and the environmental regulators will approve use of herbicides.

City of Broomfield Comments
Draft Interim Measure/Interim Remedial Action (IM/IRA)
for Operable Unit 7 (IHSS 114) and RCRA Closure of the RFETS Present Landfill

Comment No. (Ref.)	Comment	Response
1	If this document is to serve as the Closure Document, it does not contain the details to verify if the requirements of the cover have been engineered to meet the closure criteria.	This IM/IRA does serve as the Closure Document for the Present Landfill and provides a conceptual description of the proposed action (see Section 4), meeting the requirements for closure under 40 CFR 265 (see Section 6). The design of the accelerated action will provide detailed design drawings, specifications and quality control procedures for the construction of the cover.
2	We have reservations about the modeling that was performed based on a vegetation cover rather than the proposed cobble cover.	The proposed cobble cover was not simulated. However, the proposed cover configuration has been modified above the geosynthetic liner to provide a vegetative cover (See attached cover cross-section). The modeling presented in Appendix B was done to represent a low premeability cover as proposed in the IM/IRA.
3	The proposal to install a Resource Conservation and Recovery Act (RCRA) cover instead of the initial proposed evapotranspiration (ET) cover may have some long-term stewardship ramifications that were not addressed in the revised document during the alternative analysis.	Long-term stewardship is a consideration in the evaluation of the proposed action and is discussed within the IM/IRA in Appendix A.
4	The Present Landfill was allowed to receive waste until March 1998 and operate as a RCRA Interim Status Unit. The decision document allows the Present Landfill to be closed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which may allow for less stringent criteria associated with long-term operations and maintenance of the unit versus closure in accordance with RCRA. The title of the document itself alludes to the closure of the RCRA landfill. We therefore believe the substantive cleanup should be virtually the same under either regime.	Please see the discussion to question 3 in the letter (attached) dated October 17, 2003 from John L. Watson of Moye Giles LLP to Jerry Henderson, RFCAB.
5	Our next issue is associated with the seep and the Site's proposal to use the CERCLA exemption to discharge a hazardous waste in accordance with the National Pollutant Discharge Elimination System (NPDES) regulations. The leachate, which is currently a hazardous waste, is being released to a holding pond and then released to waters of the United States. Per the IM/IRA, the site proposes to use the wastewater "treatment unit exemption" to discharge the leachate as a new point source under NPDES. We understand the need to avoid over-regulation of such units by requiring both regulations, but the criteria for the exemption is quite clear and the document does not address how the criteria will be adhered to, specifically treatment within a tank.	Section 6.4.3 describes the requirements for the RCRA wastewater treatment unit exclusion and how activities at the Present Landfill meet the requirements. Very low levels of volatile organic compounds (VOC's) are occasionally measured in the seep water. The section has been revised for the final IM/IRA to state that treatment, which lowers the VOC concentration to meet discharge requirements by allowing the VOCs to volatilize though passive aeration, will occur in a tank. Final arrangement of treatment system components that promote cost-effective, safe volatilization through aeration and operation details will be developed in the detailed design of the action. EPA will review and approve the final design.

	The rational and data support associated with groundwater modeling is not clear in the document.	We believe that the rationale and the available data were reasonable, given the objectives of the modeling as documented in Appendix C. Although data are limited in some areas, we did not feel that this changed our groundwater modeling conclusions.
	There are potential data gaps that are not addressed in the document. We request additional information be provided to support the proposal along with the justification for the selection of the components of the proposed cover, design specifications, and impacts to the landfill pond.	The proposed action is not planned to impact the pond. The design process has determined that the existing pond is stable and that the existing overflow is operational. Section 4 describes the selection of the components of the proposed cover, and the design will include more detailed design drawings, specifications and quality control procedures for review and approval by the EPA. In addition, the sediments in the East Landfill Pond will be removed and placed under the RCRA-compliant cover at the Present Landfill.
	Conflicting information exists related to groundwater hydrology and conductivity. With conflicting data related to groundwater, we believe the monitoring regime based on modeling will not be adequate to confirm if the remedy is protective to human health and the environment and functioning per design.	The comment does not identify any specific conflicting information related to groundwater hydrology and conductivity. The ground water monitoring regime proposed for this action consists of an adequate number and location of monitoring wells to meet regulatory requirements for post-closure monitoring pursuant to RCRA and CHWA. The proposed monitoring is adequate to evaluate the continuing effectiveness and protectiveness of the action.
	Broomfield is concerned with the lack of long-term stewardship planning to ensure the remedial action is protective of human health and the environment. The proposed monitoring did not take into consideration the persistence, toxicity, mobility and propensity to bioaccumulate of such hazardous substances and their constituents within the landfill once the cover has been placed.	Long-term stewardship considerations specific to the Present Landfill are identified within the IM/IRA in Appendix A, including a table summarizing the long-term stewardship considerations. The RFCA parties determined, based on historical monitoring data for the seep, that VOCs and metals are good indicator parameters for changes in the seep water quality. If in the future statistically significant increases in these analytes are observed, the RFCA parties will evaluate if the monitoring program or the treatment system should be changed.
	Broomfield, as the most impacted community from this IHSS, has reservations about the stewardship criteria and the potential to identify contaminant migration both on-site and off-site post-closure.	The long-term stewardship considerations presented in the IM/IRA (See Appendix A) are consistent with long-term stewardship considerations being discussed with the community and regulators.
	Broomfield's General Comments - Landfill	
	Broomfield is concerned with the lack of source characterization presented in the IM/IRA. Without adequate characterization to determine the nature and extent of the contaminants, we do not understand how an assessment can be made for the remedy and long-term monitoring and surveillance of the cover. A table should be included in the document to identify each media, the contaminants of concerns, potential contaminants of concerns, background levels, and action levels and/or standards.	The proposed action is to close the Present Landfill with a RCRA subtitle C compliant cover. This closure implements the CERCLA presumptive remedy for the Present Landfill (the source of contamination) of source containment. The substantive requirements for closure under RCRA Subtitle C are identified as ARARs. Under the CERCLA presumptive remedy guidance, operational history, process knowledge and existing characterization data are usually sufficient to determine whether the source containment remedy is appropriate. This information is extensive for the Present Landfill. Additional characterization of a landfill's contents is not necessary or cost-effective; rather, existing data are used to determine whether the containment presumption is appropriate (per OSWER Directive 9355.0-49FS). A Landfill cover, or cap, is a presumptive remedy

		component, based on historical patterns of remedy selection and on EPA's scientific and engineering evaluation of performance data for such landfill covers. The cover will meet specific design and construction standards as identified in the ARARs Section 6.0 and in Appendix F. Maintaining the integrity of the cover is discussed in 6.1.1 and Appendix A. See Section 2.0 for media specific comparisons to RFCA action levels.
	We understand a separate Cover Design will be drafted, but as a minimum the IM/IRA should address in more detail; erosion protection, runoff protection, infiltration, frost protection of the geosynthetic clay liner (GCL) layer, biota barrier, life-cycle expectancy of the cover and its components, and a Contingency Plan in the event the cover needs to be replaced or the east slope of the landfill slips. We are concerned the cobble cover is not deep enough to act as a biota barrier and the mix of cobbles should be more variable to prevent weathering effects, growth of vegetation, and prevent erosion. Per previous discussions, we have voiced concerns about protecting the GCL from freeze-thaw cycles. To avoid the degradation of the GCL, the layer should be below the frost line and this is not identified in the document. Revise the document to identify the freeze-thaw line or the method the Site will use to ensure protection of the liner. The IM/IRA does not identify how the requirements of the cover will meet the requirements of a RCRA Subtitle C cover and this information should be included in the document. Finally, the document states benchmarks will be used but does not provide the details of the use and how many benchmarks will be placed to evaluate the cover. Add language to clarify how and where benchmarks will be used.	The details of the proposed action will be developed in the detailed design. The detailed design will include erosion control, run-on and runoff control, frost protection, settlement monitoring and the detailed specifications for each layer of the cover. The cover meets the requirements of RCRA as described in Section 6.0. As stated in the IM/IRA, Section 5.0, the GCL will be placed below the frost line calculated during the detailed design. Additionally, the cover configuration above the geosynthetic liner has been modified to include a biota barrier immediately above the liner and a vegetative soil cover above biota barrier (See attached cover cross-section).
	Broomfield's General Comments **Integrated Hydrologic Model for the Present Landfill**	
	The IM/IRA has a very detailed integrated hydrologic model for the Present Landfill. Broomfield is very concerned one of the very key inputs to the model was not addressed. Through out the calibration, validation, and sensitivity analysis, the model assumed a vegetation cover, thus evaporation and plant transpiration were incorrectly addressed. The model assumed a mesic vegetation on the cover and does not address the water analysis with a cobble cover. To measure additional groundwater volume without knowing the evapo-transpiration (ET) loss makes us questions the affect on groundwater recharge. The assumption can not be made to assume ET is greater than the recharge with a cobble cover. Justify why the modeling assumed a mesic vegetation cover and did not reflect the actual proposed cover. What is the potential evapo-transpiration (PET) component of a cobble cover and what is the impact to the groundwater flow within the landfill? The model also assumes no overland flow, what about overland flow in the eastern section of	The calibration, sensitivity and validation of the fully integrated Present Landfill model did in fact simulate spatially distributed vegetation (please see Figure 6-1). Moreover, the spatial distribution accounts for differences in vegetated and disturbed soil areas as shown on Figure 6-1. Of course, over the period from 1993 through mid 1995, a single spatial distribution of vegetation was input to the model as the changes in vegetated areas compared to disturbed soils did not change dramatically and this information was limited The model does in fact simulate overland flow, as it is a fully integrated model, though, it does not simulate this for a cobble cover.. However, the proposed cover configuration has been modified above the geosynthetic liner to provide a vegetative cover (See attached cover cross-section). The modeling presented in Appendix B was done to represent a low premeability cover as proposed in the IM/IRA.

	the landfill? The M-value is a representation of the roughness of the surface. A roughness of M = 5 was specified for all areas. The roughness was based on disturbed land and partially compacted areas such as dirt roads, landfill, dam and buildings. Clarify what roads and buildings were used in the modeling. The assumption has been made the pond will normally discharge once it reaches a certain level. Why did the site not assume the current pond operations would continue? 1993 and 1994 were used to calibrate the groundwater levels. Were these years with average rainfall? During the sensitivity analysis was a 15, 50 or 100 year storm simulated in the model? Once again, to generate a hypothetical scenario of the landfill with a vegetated cover is not representative of the proposed remedy. The scenario assumed the landfill area is covered with 0.3 meters of cover material and having the landfill area be fully vegetated with mesic vegetation or with a cover less than 0.3 and less established vegetation. Provide us with the calibration, validation, and sensitivity analysis of the proposed remedy. Clarify why some of the figures identify areas to the west of the landfill boundary.	A surface roughness value of 5 was in fact used for the entire landfill area because differences were not expected to be significant. Part of this reason is that little overland flow is actually generated in the model (i.e., see Figure 7-1) for various precipitation events as the surface soils are generally fairly permeable. Therefore, under the climate conditions under which the model was tested, surface roughness has only a limited influence on overland runoff. Surface runoff is predicted to occur mostly in near-stream drainage areas and is probably more due to saturation excess, or variable source areas caused by groundwater saturating the ground surface that causes a fast overland runoff response. The 1993 and 1994 rainfall years were relatively normal, but the following 1995 year represented at least a 15-year high annual volume of precipitation. A 15, 50, or 100-year storm was not simulated for the closure scenario. As stated in Appendix B, Section 8.1.2, A "wet year" climate sequence from the Site Wide Water Balance (SWWB) (KH 2002a) was used to pertubate the system to simulate climatic uncertainty. A "wet year" as defined in the SWWB is the largest amount of annual precipitation within a 100 year period. The integrated Present Landfill model incorporated areas west of the actual landfill area so that boundary conditions would not impact the groundwater calculations internal to the landfill.
	Broomfield's General Comments – Alternative Analysis Evaluation	
4	Does not oppose the proposed plan to utilize a standard RCRA cover. What Broomfield does not understand is the change in rational in the alternative analysis performed last year versus the alternative analysis in the revised document we are currently reviewing. Last year it was not known if the landfill was impacting groundwater, or if groundwater was impacting the landfill. Provide the current basis for assuming 10% of the leachate is generated from groundwater and 90% is generated from infiltration. A previous document stated the leachate consisted of 40% groundwater and 60% infiltration. Provide the basis for the significant departure from previous studies and reports.	DOE received comments on the previous IM/IRA requesting that groundwater be evaluated as part of the remedy for the landfill. Additional evaluations have been completed and the proposed accelerated action includes these evaluations. The basis for 90% infiltration versus 10% lateral groundwater inflow rather than previous 60% infiltration and 40% lateral groundwater inflow is due to differences in how the landfill area was modeled. The previous modeling only considered groundwater flow (i.e., only a groundwater model), while the recent results are derived through integrated modeling that considers the coupled behavior of overland flow, unsaturated zone flow and saturated zone flow. More information is used to calibrate the integrated model. For example, short-term groundwater level fluctuations over multiple years and seep discharge (and semi-quantitative observations that overland flow is limited) are used to calibrate the integrated model. This model also simulates the transient behavior of groundwater flow conditions, while former groundwater modeling assumed steady state conditions and assumed the spatial and temporal distribution of groundwater recharge, a critical factor in simulating groundwater flows within and surrounding the present landfill. Former modeling had no basis for calculating the recharge and as such,

		could not calculate the infiltration versus lateral groundwater inflow accurately. The integrated model calculates the complex spatial and temporal recharge to the groundwater system within and external to the landfill waste area by reproducing key groundwater level fluctuation characteristics such as timing of major annual recharge events, approximate magnitude of groundwater level adjustments to these recharge events and subsequent drainage response to these perturbations. The integrated model results showed clear differences between landfill waste wells and those external to the wastes in terms of these characteristics. As such, we believe that the integrated model produces more realistic and accurate results.
5	An intermittent seep has been observed north of SW097 on the hillside just below the north asbestos disposal area. The seep is most likely caused by saturated materials related to storm events. There have been recent observed slumps this area. The IM/IRA does not address this area or seep in the alternative analysis. What is the long-term maintenance costs associated with maintaining the cover in this area if it has a potential for future slumping?	The proposed cover, equivalent to a RCRA Subtitle C cover, will encompass this area of concern to reduce infiltration of storm water and the area will be regraded to establish more stable slopes.
6	Last year we were informed some preferential flow paths existed in the weathered bedrock, most likely due to fractures in the weathered bedrock. These flow paths could be potential contributors to the migration of contaminants in the weathered bedrock. Provide us with the new information that suggests groundwater is not migrating in this area and the basis to assume there are no fractures in the weathered bedrock. Again, conflicting information in documents leads us to question the validity of the analysis.	DOE received comments on the previous IM/IRA requesting that groundwater be evaluated as part of the remedy for the landfill. Additional evaluations have been completed and the proposed accelerated action includes these evaluations. Due to the construction of the landfill into the weathered bedrock and the East Landfill Pond dam construction into the unweathered bedrock, preferential groundwater flow paths do not seem to exist. As shown in the integrated model; groundwater within the landfill discharges through the existing seep. The groundwater immediately downgradient of the East Landfill Pond will be evaluated in the RFETS Groundwater IM/IRA.
7.	The proposal discusses a continued use of the existing network of Integrated Monitoring Plan (IMP) groundwater wells to monitor groundwater. Three of the four downgradient wells are usually dry and Broomfield is concerned the wells may not be cited in the optimal location. The wells must be in locations to adequately monitor changes to the landfill. Did the alternative analysis consider failure of the remedy and the cost to replace the remedy in the event groundwater continues to show an increase in contaminant levels? The document identifies four upgradient wells and four downgradient wells to monitor the groundwater in this area and the additional groundwater wells that constitute the monitoring network should be identified in the IM/IRA. The alternative analysis should be revised to include the replacement cost of the two covers in the event of remedy failure.	In 1986 groundwater monitoring focused on compliance with RCRA requirements and 20 wells were located upgradient and downgradient of the Present Landfill Operable Unit 7, with approval from both regulatory agencies. Historical locations of wells have been around the landfill, within the landfill, between the landfill and the East Landfill Pond, upgradient of the landfill and downgradient of the landfill and pond. All of these locations have been approved by both regulatory agencies. In July 1996, when RFCA was adopted, the entire RFETS groundwater monitoring network (including 25 wells around the Present Landfill) was evaluated, to align the RFETS groundwater monitoring program with the new RFETS mission and RFCA requirements. A data quality objective (DQO) process was used to determine the decisions that were necessary for groundwater and the function of each well in the network in supporting those decisions. DOE, CDPHE and EPA were directly involved in decisions involving the monitoring network and which selected the current 8 RCRA wells for the Present Landfill. Results of this evaluation are presented in the 1996 Annual RFCA Groundwater Monitoring Report. The location of these 8 RCRA wells, which are currently proposed for

		continued groundwater monitoring, were approved by the regulatory agencies. The current downgradient groundwater monitoring wells are optimally located since they are within the same drainage in which the landfill is located and they were placed downgradient of both the landfill and the pond. It is not unusual for wells to be dry during dryer periods due to the nature of groundwater recharge and flow at RFETS. During a 35-year period the Present Landfill has shown little impact to downgradient groundwater quality prior to closure. The proposed action in this IM/IRA is to close the Present Landfill by placing a RCRA Subtitle C equivalent cover over the landfill, which is designed to minimize infiltration through the landfill and provide an overall positive impact to groundwater quality. No significant impact to groundwater quality is expected from this action, since no significant impact to downgradient groundwater quality is currently observed. Post-closure monitoring of this landfill will continue to determine changes in downgradient groundwater quality. Groundwater monitoring data will be evaluated in accordance with RFCA Attachment 5, Section 3.0 to determine if any additional actions are required. This information is discussed in Appendix A. The alternative analysis did not consider a failure of the remedy that would require a total replacement of the cover. Complete remedy failure is not a reasonable assumption given the fact that currently a soil cover is currently in place and is performing well. Analysis that includes replacement of a remedy because of complete remedy failure is not required under CERCLA; rather, an evaluation of technical implementability, effectiveness and other factors is done to consider whether the alternative is reasonable and cost-effective.
8	We understand the document states the ET cover has a much higher short-term risk due to the amount of vehicles used to transport fill material than the proposed RCRA cover. The document explains this is why the Site decided to choose a RCRA cover as the preferred remedy. Both covers are equal in terms of remedy and estimated capital cost. Yet, last year the Site was concerned about the long-term effectiveness of a RCRA cover in an arid climate and the potential costs of maintenance post-closure. The RCRA cover will require more complex maintenance and long-term costs than an ET cover based on the potential of failure from man-made materials. We are concerned the Alternative Analysis did not provide the details of the study, which should have evaluated the long-term cost analysis in addition to the short and long-term risk of the identified remedies. One of the RCRA closure requirements is to minimize the need for further maintenance and the ET cover appears to	Long term maintenance would be required on both the proposed cover and an ET cover. The evaluation of the cover alternatives considers the overall short-term and long term impacts of action and considers that the long term maintenance requirements of the proposed action are generally less than the short term negative impacts of the ET cover. The site was concerned about the desiccation of a traditional RCRA cover that is composed of clays. The proposed cover is not susceptible to the same concern since it is made from geosynthetic materials that are not susceptible to desiccation.

	more appropriately meet this requirement more than the proposed cover.	
	Broomfield's General Comments – Substantive Cleanup, Application of Applicable or Relevant and Appropriate Requirements (ARARs), and RFCA Attachment 10	
)	Broomfield understands the ability to close the unit in accordance with the CERCLA provisions under section 121. Except for the permit requirements, the substantive cleanup should be the same under either regime of CERCLA or the Colorado Code of Regulations [CCR] 1007-3, Part 265.111. Broomfield wants to ensure all the requirements for closure of an interim unit are consistent with the requirements of this document.	Section 6.1 outlines how the Present Landfill will be closed in accordance with the substantive requirements for RCRA closure, specifically 6 CCR 1007-3, § 265.111. Achieving RCRA interim status closure was also identified as an RAO in section 3.0.
0	Clarify if the IM/IRA serves as the Closure Document. If this plan acts as the official Closure Plan, it does not provide the detail needed for a Professional Engineer to certify closure of the unit. Revise the document to include the certification process or identify if the Present Landfill will have a separate stand alone Closure Document.	This document serves as the RCRA Closure Plan for the Present Landfill. The following sentences will be added to the first paragraph of under Section 6.1, after the first sentence: "This section of the IM/IRA is the Closure Plan for the Present Landfill and this IM/IRA serves as notification to CDPHE of the pending closure of the Present Landfill." A new section 6.1.4. will be added, titled, "Closure Activities": "The overall project approach is presented in Section 5 of the IM/IRA. Detailed design specifications will be presented in the final design documents. The construction contractor will be held in strict conformance to the final construction design drawings and specifications. QA/QC inspection and testing will be performed during construction of the RCRA equivalent Subtitle C cover in accordance with the Construction Quality Control (CQC) Plan that outlines specific inspection and testing requirements for all materials and construction performance, necessary documentation, procedures for correcting nonconforming items, and the party responsible for each aspect of the CQC. All materials and placement of materials for the cover will be subject to inspection and testing to ensure conformance to the specifications. Ancillary activities performed concurrently with construction of the RCRA equivalent Subtitle C cover will include protection of wetlands, surface water management, and site security. A wetland mitigation plan will be added as an appendix to the IM/IRA. Grading the surface of the landfill will control surface water run-off. Surface water will drain to the perimeter drainage ditches and routed to No Name Gulch. The water level in the East Landfill Pond may be lowered to allow better access for construction activities during closure by transferring water to Pond A-3. Seep management and landfill gas monitoring will be performed as a continuation of the accelerated action until construction of the cover begins.

		Site security will be maintained during and after construction activities. A fence surrounds the Present Landfill, prohibiting access by unauthorized personnel. Gates will be installed for construction access. Signs will be posted warning of potential danger at the landfill." A new section 6.1.5 will be added, titled " Closure Certification": "After installation of the RCRA equivalent Subtitle C cover, DOE will provide CDPHE with a certification that the Present Landfill cover has been installed in accordance with the final, approved design documents (including approved changes and field modifications, if applicable). An independent, registered, professional engineer will sign this certification. " PE certification is an administrative requirement and is not required for the IM/IRA, only for the closure certification report.
1	Include the comparisons for upgradient wells and downgradient wells once the remedy has been completed to determine if the landfill is impacting groundwater. If significant differences occur in the comparisons or water quality standards increase or pH decreases, the State, EPA, and impacted local governments should be notified within15 days after receiving confirmation of the analyses.	As stated in the IM/IRA, a groundwater monitoring system was implemented under the IMP and contains a total of 8 RCRA wells (4 upgradient and 4 downgradient) for the Present Landfill. Monitoring of these wells will continue in accordance with this IM/IRA, which compares upgradient groundwater quality to downgradient groundwater quality. If concentrations at a downgradient well increase with time, it will be addressed in accordance with the IM/IRA.
2	The Rocky Flats Cleanup Agreement (RFCA) Attachment 10, states the Department of Energy (DOE) DOE as a minimum shall have two design criteria for units where a cap/cover is placed. The design concentration limits (DCLs) should *be calculated on a unit-specific basis for ground water passing the downgradient unit boundary.* DCLs were not identified within the document. RFCA further states *DCLs assume an ongoing release from the unit, but at levels that are protective of human health and the environment, consistent with the RFETS Vision.* Clarify if the DCLs are equal to the water quality standards listed in table 1 of Attachment 5. RFCA further states *alternate concentration limits (ACLs) should be calculated on a unit-specific basis for groundwater passing the downgradient unit boundary.* The IM/IRA does not identify an ACL and the document states an ACL will not be identified. Clarify why the Site is not adhering to the requirements of RFCA pertaining to the Present Landfill. Once the ACLs are developed, their data points would provide us assurance the methodology for evaluating water quality is adequate and the water quality itself is protective of human health and the environment.	DOE is adhering to the requirements of RFCA pertaining to the Present Landfill. Section 6.2 discusses RFCA Attachment 10. RFCA Attachment 10 allows for the calculation of DCLs and ACLs, but does not require that DCLs or ACLs be calculated. The Present Landfill is not contaminating groundwater, except for groundwater exiting at the seep. The seep is not impacting surface water quality at the East Landfill Pond. The originally proposed and modified proposed cover is a cover equivalent to RCRA Subtitle C requirements. Neither cover design was based on a specific DCL calculation, but rather upon a design infiltration rate that meets RCRA Subtitle C requirements and guidance criteria. Because groundwater is not impacting surface water and the proposed cover will perform better than the current soil cover, no DCLs are calculated. The conclusion of section 2.6.3 is that groundwater from the landfill is not impacting surface water quality. Therefore, no ACLs are calculated.
23	Points of compliance for the seep and the groundwater wells should be identified in the document along with the water quality standards and	The IM/IRA states that eight (four upgradient and four downgradient) RCRA groundwater monitoring wells have been established for the Present Landfill

	contaminants of concern. We understand the proposal is titled an interim measure, but all the key decisions for the closure of the landfill along with the proposed remedy have been identified. Therefore, we believe the compliance points should also be identified in the document along with the stewardship criteria.	pursuant to RFCA and RCRA. The Im/IRA also states that the existing downgradient RCRA groundwater monitoring wells will be groundwater POC wells for RFCA Attachment 10. Changes in downgradient versus upgradient groundwater quality as measured at these wells will require consultation between the RFCA Parties to determine if changes to the remedy are required. This approach is consistent with the ARARs for closure of an interim status unit. The seep treatment system is part of the accelerated action and the treatment tank effluent is regulated under the IM/IRA. The IM/IRA (See Appendix A) describes the monitoring requirement, including effluent limits, for the seep treatment system. The NPDES outfall for the treatment system is at the point of discharge from the treatment tank.
24	The City & County of Broomfield supports the States' Environmental Covenants Law. This law would provide an additional layer of institutional controls, which is needed in the event of failure of a single institutional control. The City & County of Broomfield also supports having CDHPE and EPA in an enforceable oversight role post-closure to monitor long-term stewardship activities. Revise the document to include the Colorado State Covenants Law as an ARAR.	This comment is beyond the scope of the Present Landfill IM/IRA. The RFCA Parties are considering the needs and requests of all stakeholders after the completion of accelerated actions. However, the RFCA Parties are discussing the applicability of this statute to the federal government. Additionally, the proposed action for the Present Landfill presented in the IM/IRA is an accelerated action under RFCA; therefore, the Environmental Covenants Law is currently not considered an ARAR for the Present Landfill.
25	Clarify why 5CCR 1001-4 CAQCC Regulation No. 2 is not included in the document.	This regulation was not identified as an ARAR since there is no potential for an odor to impact off-site receptors.
26	Appendix E identifies the parameters that will be monitored and they include VOCs and metals. *The effluent limits are the surface water standard applicable for the receiving water as listed in RFCA Attachment, table 1.* The citation should be table 1, Attachment 5. To meet federal water pollution control discharge criteria, other parameters and constituents need to be added to the lost of analytes such as physical parameters, Walnut Creek water quality standards, and 40 CFR Part 445 criteria.	Appendix E (now Appendix F), page E-3, Federal Water Pollution Control Act, the second sentence in the Comment section will be corrected as follows: "The effluent limits are the surface water standards applicable for the receiving water as listed in RFCA Attachment 5, Table 1." The constituents currently associated with the Present Landfill seep and identified in this decision document are benzene and vinyl chloride. RFCA parties agreed, based on historical monitoring data for the seep, that good indicator parameters for changes in the seep water quality are VOCs and metals. If in the future statistically significant changes to the seep water quality are observed, the RFCA Parties will evaluate if the monitoring program or the seep treatment system should be changed.
27	Clarify why 5CCR 1002-41 was deleted from the ARAR table. Action levels for groundwater are identified in Attachment 5 of RFCA and still are applicable for groundwater action levels.	It was incorrect to identify the groundwater action levels as an ARAR for this proposed action. Since the Present Landfill is being closed under the RCRA/CHWA interim status unit requirements as an ARAR, it is more correct to compare upgradient to downgradient water quality as discussed in the IM/IRA.
28	Storm water criteria per 40 CFR 122.26 applies to the project. Why was this	40 CFR 122.26 was included in Appendix E (now Appendix F).

	ARAR not included in the document?	
9	ARARs for floodplain/wetland protection were not identified. ARARs for endangered and threatened species were also not identified. Wetlands exist in this area. Do any ARARs for wetlands or endangered and threatened species apply to this specific IHSS? If the holding pond needs to be dredged, do any other ARARs apply and will a 404 permit be required?	Please see section 2.5.9. Neither the proposed or modified proposed action impact floodplain areas; therefore, ARARs related to the protection of floodplain protection were not identified as ARARs. The Prebles Meadow Jumping Mouse has not been found in the Present Landfill area. The proposed action will impact a small portion of the wetlands at the Present Landfill. DOE is required to mitigate impacts to wetlands, and a more detailed wetlands mitigation plan will be included as an appendix to the final IM/IRA. The East Landfill Pond will not be dredged as a part of the proposed accelerated action.
0	Clarify if the Fish and Wildlife Coordination Act, 16 USC 661 *et seq*. applies.	These potential ARARs were incorrectly identified in the August 6, 2002 draft IM/IRA. The Act is not an ARAR for the accelerated action.
1	The National Historic Preservation Act, 16 USC 470, et seq. may apply if archaeological resources or American antiquities are encountered. Clarify why this act was excluded from the list of ARARs.	There are no archaeological resources or American antiquities in the area of the proposed action.
	Broomfield's General Comments – Seep and Pond Management	
2	Broomfield is concerned that it took the Site so long to adequately characterize the seep as a RCRA regulated waste stream that is generated from a multisource of listed hazardous wastes. In our letter dated September 19, 2002, we asked for the rational as to why the F039 did not apply to the leachate or to water in the holding pond. What are the closure implications of the holding pond because it served as a land disposal impoundment for the leachate? The document addresses closure of the landfill, but not closure of the pond as a RCRA unit. We recommend the pond closure criteria be added to the document to be inclusive of the entire IHSS area, not just the waste disposal area.	Historically the seep has been managed primarily as emerging groundwater, with very low levels of constituent contamination from infiltration from the landfilled waste, which flows into the pond. Other sources of water contribute to the landfill pond. Previous response actions employing active and passive treatment of the seep have been implemented for years to remove waste constituents prior to discharge to surface water. Because appropriate treatment levels were established in these actions, the pond has not been considered an impoundment for hazardous waste. The IM/IRA continues to adopt this approach, but further establishes and clarifies the NPDES treatment requirements prior to discharge to surface water.
	The Site has stated that it intends to delist the leachate in the near future. Please provide the process and data that will be used to delist the waste stream. If the leachate is delisted and no longer considered a hazardous waste; will the monitoring discontinue even thought the water will still be released to waters of the United States? Please keep us apprised of the status of the delisting process.	Under the regulatory approach described in the IM/IRA delisting of the leachate is not required. If the regulatory approach were to change in the future and it is determined that delisting is required, then the delisting process required in 6 CCR 1007-3 §§ 260.20 and 260.22 would be followed.
	Clarify if the concentration ranges for the sediment concentrations in the ponds are total concentrations. If the concentrations are not totals, some of the contaminants could be RCRA regulated. Broomfield is concerned the data	As stated in Section 2.6.5, Table 3, sediment concentrations are reported in mg/kg or µg/kg, which are total concentrations of contaminants detected. Sediments were sampled in the mid 1990's. Since the mid-1990's, VOCs were identified as the

	used for the sediment in the ponds is from the 1994 OU 7 Final Work Plan Technical Memorandum. Almost a decade has elapsed since the last sampling evolution and we recommend additional sampling be performed to adequately characterize the sediment so the present concentration of contaminants is known. Recent data will also assist with the ecological risk assessment to determine if the sediments will require remediation.	only constituents requiring treatment in the seep treatment system. VOCs are not expected to have impacted the East Landfill Pond sediments. The IM/IRA has been revised to include the removal of the sediments in the East Landfill Pond and placement of the sediments under the RCRA-compliant cover at the Present Landfill.
3	As previously stated, we understand the regulatory provision to discharge the leachate in accordance with NPDES and qualify for the wastewater treatment unit (WWTU) exemption. Broomfield questions how the exemption is being meet per the following criteria: "*Wastewater treatment unit means a device which:* *(1) Is part of a wastewater treatment facility that is subject to regulation under either Section 402 or 307 (b) of the Clean Water Act; and* (2) Receives and treats or stores an influent wastewater that is a hazardous waste as defined in §261.3 of this chapter, or that generates and accumulates a wastewater treatment sludge that is a hazardous waste as defined in §261.3 of this chapter, or treats or stores a wastewater treatment sludge which is a hazardous waste as defined in §261.3 of this chapter; and (3) Meets the definition of tank or tank system in §261.10 of this chapter."	Section 6.5.3 describes the requirements for the RCRA wastewater treatment unit exclusion and how activities at the Present Landfill meet the requirements. Very low levels of volatile organic compounds (VOC's) are occasionally measured in the seep water. The section has been revised for the final IM/IRA to state that treatment, which lowers the VOC concentration to meet discharge requirements by allowing the VOCs to volatilize though passive aeration, will occur in a tank. Final arrangement of treatment system components that promote cost-effective, safe volatilization through aeration and operation details will be developed in the detailed design of the action. EPA will review and approve the final design.
34	Broomfield understands to adhere to the above-mentioned criteria; the Site intends to treat the leachate in a tank with an aeration system. The proposed design of the system should be included in the document along with the post-closure surveillance and monitoring of the system. As a minimum the revised IM/IRA should include: • Design of the tank and treatment unit • Alternative analysis for the tank system • Identify the point source of compliance, which should be at the effluent discharge of the treatment tank • Identify the analytes required to meet the NPDES discharge • Identify the parameters which would implement a Contingency Plan to identify further evaluation or further corrective actions • Identify the required maintenance and surveillance of the unit • Identify physical inspection criteria of the outflow if the seep no longer discharges effluent • Identify inspection criteria after a major storm event of the unit	The IM/IRA provides the conceptual plan for the seep treatment system. The details of the seep treatment system will be developed in the detailed design. Appendix A describes the monitoring requirements, including effluent limits, for the seep treatment system. The NPDES outfall for the treatment system is at the point of discharge from the treatment tank. The RFCA Parties agreed, based on historical monitoring data for the seep, that VOCs and metals are good indicator parameters for changes in the seep water quality. If in the future statistically significant changes to the seep water quality are observed, the RFCA Parties will evaluate if the monitoring program or the treatment system should be changed. The other seep treatment options, as described in Section 4 are considered viable alternatives to be used as contingency should the proposed action not meet the treatment requirements. A detailed maintenance and monitoring plan will be developed for the seep treatment system during the detailed design.
35	The proposal to discontinue monitoring of the seep within the first two to four years is unacceptable to the City & County of Broomfield. As asset holders of	Appendix A describes the monitoring requirements for the seep. The text states that during the CERCLA periodic review, the RFCA Parties will evaluate whether

surface water downgradient from the site, we do not agree this condensed time period is sufficient to obtain sufficient data points to evaluate the impact from the remedy. The remedy may increase the concentration of contaminants or physical composition in the seep over a longer period than just two years. Without monitoring we cannot evaluate impacts to surface water quality.	continued monitoring is required after a proposed sampling period. The time frame itself does not mean that sampling could discontinue automatically. The evaluation will include a thorough data analysis. The text of the IM/IRA (See Appendix A) will be modified to present that seep monitoring will occur quarterly. The RFCA parties can adjust the frequency of sampling; however, based on the regulations, the monitoring frequency will be at least annually.
The RCRA rules have a rebuttable presumption that post-closure care should last 30 years. Post-closure care includes monitoring. Once again we are aware both EPA and CDHPE can reduce the monitoring period if they have sufficient data to protect human health and the environment. The data reviewed should be data complied after completion of the remedy, not data gathered prior to the remedy as alluded to in the document. The RFCA Parties will have to justify the rational to rebut the presumption for the RCRA rule. As a minimum, a full suite of analytes should be monitored annually until sufficient data has been gathered to perform an evaluation of the leachate. Once sufficient data has been gathered to determine the potential effect from the remedy to identify trending of the analytes, an evaluation of the sampling and analysis plan should be initiated. As a minimum, all water quality standards for the receiving water which is Walnut Creek and 40 CFR Part 445 should be applicable. Based on the analytical data review, the sampling and analysis plan could then be revised.	RCRA post-closure care addresses groundwater monitoring and not surface water monitoring or seep monitoring. The monitoring period for the Present Landfill will be identified initially as 30 years (See Appendix A), recognizing that the regulatory agency may shorten this post-closure care period, if a reduced period is sufficient to protect human health and the environment. This evaluation will be conducted during the CERCLA periodic review period. The RFCA Parties agreed, based on historical monitoring data for the seep, that VOCs and metals are good indicator parameters for changes in the seep water quality. If in the future statistically significant changes to the seep water quality are observed, the RFCA Parties will evaluate if the monitoring program or the treatment system should be changed.
In addition, there is no discussion to sample the two other seeps. In the event the major seep has an exceedance, what are the contingency plans to monitor the other two seeps? Add a map to the document which identifies the location of the seeps in this IHSS and the drainage path of the seeps. If the RFCA Parties choose to discontinue monitoring and still continue to discharge to waters of the United States, we ask for the regulatory citation that allows for such a relief to discharge surface waters to waters of the United States without any type of monitoring.	An additional intermittent seep has been noted during historical sampling events at the Present Landfill. However, SW097 has historically been determined to be the primary seep emanating from the Present Landfill and as such, has been the focus of past and present monitoring activities. All seeps associated with the Present Landfill flow to either the passive seep interception and treatment system or to the East Landfill Pond. Construction of the RCRA equivalent subtitle C cover over the Present Landfill area will include those areas where intermittent seeps have existed in the past. As a result, intermittent seeps will no longer be present at the Present Landfill. Appendix A describes the monitoring requirements for the seep.

	Once the site is de-listed off of the National Priorities List (NPL) and no longer is a CERCLA site, will DOE have to obtain a NPDES permit to continue releasing to waters of the United States? If a permit is required, revise the IM/IRA to identify the process for obtaining a permit if required.	The Site will be eligible for deletion from the NPL when no further response is required, all cleanup goals have been achieved, and conditions at the site are deemed to be protective of human health and the environment. A response action involving surface water treatment is considered to be complete when the system is constructed and is operating as intended to achieve cleanup goals. If DOE discharges a regulated pollutant into waters of the state and the discharge is not related to a removal or remedial action, an NPDES permit may be required.
	The current draft IM/IRA states: "the East Landfill Pond will be modified to include an outlet structure to allow water in the pond to flow into the existing drainage when the water level reaches a specific level. The details of the flow through outlets structure will be developed in the design." Broomfield strongly disagrees with releasing the pond water into No Name Gulch. As a community that is downstream from the existing drainage, we oppose releasing any waters into Walnut Creek that will not be sampled to determine the impact to water quality entering our community. We have worked diligently with the Site to determine cleanup levels in the soils and surface water technical memorandums to ensure protection of surface water quality in Broomfield. To ensure long-term protection and monitoring of surface water post-closure, Broomfield intends to see the water diverted to the A- or B-series ponds prior to release into natural drainages. Our rational is to provide an additional layering tool to measure the quality of surface water prior to its' release off-site. Water quality will additionally be measured at the outfalls of the A- or B-series ponds and at the point-of-compliance (POC) at the site boundary at Indiana. In the event surface water being released into No Name Gulch does not reach Walnut Creek per the proposal, groundwater quality may be impacted from infiltration of the surface water.	Based on historic samples, the Present Landfill has not impacted water quality at the East Landfill Pond and DOE believes that it is reasonable to retain the pond's existing outlet structure to allow water in the pond to flow into the existing drainage when the water level reaches a specific level. In addition, the seep water will be sampled after treatment and prior to discharge to the East Landfill Pond. If an elevated level is detected, then the East Landfill Pond water would be sampled. If the East Landfill Pond water sample contains levels above the action levels in RFCA Attachment 5, Table 1, then the RFCA Parties will evaluate if the East Landfill Pond water can be released or should be managed in some other way. The East Landfill Pond water will not be sampled prior to its release unless there is a seep treatment system sample result above effluent limits. In addition, the sediments in the East Landfill Pond will be removed and placed under the RCRA-compliant cover at the Present Landfill.
	Broomfield's General Comments – Groundwater Hydrologic Flow Model, Assessment, and Monitoring	
7	The City & County of Broomfield is concerned the sampling methodology for the groundwater wells was developed outside of the current RFCA process to assess the groundwater network. A process to identify the data quality objective (DQO) is needed to determine what decisions are necessary for groundwater in this area. In addition, the function of each well in the network has to be identified with information supporting those decisions. We are very concerned with the process, which excluded us from identifying the groundwater monitoring criteria pursuant to RFCA.	In 1986 groundwater monitoring focused on compliance with RCRA requirements and 20 wells were located upgradient and downgradient of the Present Landfill Operable Unit 7 and sampling included the hazardous substance list VOCs, SVOCs, metals, major ions and radionuclides. This was done in accordance with the 1986 RCRA Compliance Order and CERCLA Agreement and had the approval from both regulatory agencies. Historical locations and analytical programs are summarized in Appendix A and were always conducted under a compliance order and/or agreement that involve both regulatory agencies. In July 1996, when RFCA was adopted, the entire RFETS groundwater monitoring network (including 25 wells around the Present Landfill) was evaluated, to align

		the RFETS groundwater monitoring program with the new RFETS mission and RFCA requirements. A data quality objective (DQO) process was used to determine the decisions that were necessary for groundwater and the function of each well in the network in supporting those decisions. DOE, CDPHE and EPA were directly involved in decisions involving the monitoring network and which selected the current 8 RCRA wells for the Present Landfill and the suite of analysis to be performed. Results of this evaluation are presented in the 1996 Annual RFCA Groundwater Monitoring Report. The location of these 8 RCRA wells and the analytical parameters VOCs and metals, which are currently proposed for continued groundwater monitoring, were approved by the regulatory agencies.
	The 1996 IM/IRA document identified generation of the seep to be from 40% groundwater and 60% infiltration. Per our discussions last year with the Site, the same information was provided to us during discussions of the groundwater hydrology in this area. The current document states the generation of the seep consists of 10% groundwater and 90% infiltration. Please provide the basis for the change in hydrology and what data was utilized to revise the previous modeling.	DOE received comments on the previous IM/IRA requesting that groundwater be evaluated as part of the remedy for the landfill. Additional evaluations have been completed and the proposed accelerated action includes these evaluations. The basis for 90% infiltration versus 10% lateral groundwater inflow rather than previous 60% infiltration and 40% lateral groundwater inflow is due to differences in how the landfill area was modeled. The previous modeling only considered groundwater flow (i.e., only a groundwater model), while the recent results are derived through integrated modeling that considers the coupled behavior of overland flow, unsaturated zone flow and saturated zone flow. More information is used to calibrate the integrated model. For example, short-term groundwater level fluctuations over multiple years and seep discharge (and semi-quantitative observations that overland flow is limited) are used to calibrate the integrated model. This model also simulates the transient behavior of groundwater flow conditions, while former groundwater modeling assumed steady state conditions and assumed the spatial and temporal distribution of groundwater recharge, a critical factor in simulating groundwater flows within and surrounding the present landfill. Former modeling had no basis for calculating the recharge and as such, could not calculate the infiltration versus lateral groundwater inflow accurately. The integrated model calculates the complex spatial and temporal recharge to the groundwater system within and external to the landfill waste area by reproducing key groundwater level fluctuation characteristics such as timing of major annual recharge events, approximate magnitude of groundwater level adjustments to these recharge events and subsequent drainage response to these perturbations. The integrated model results showed clear differences between landfill waste wells and those external to the wastes in terms of these characteristics. As such, we believe that the integrated model produces more realistic and accurate results.
;9	Previous Present Landfill documents state there may be fractured weathered bedrock underneath the landfill and groundwater may be migrating through these fractures. The current document states groundwater is being either diverted around the landfill or into or downgradient of the East Landfill Pond.	DOE received comments on the previous IM/IRA requesting that groundwater be evaluated as part of the remedy for the landfill. Additional evaluations have been completed and the proposed accelerated action includes these evaluations. Due to the construction of the landfill into the weathered bedrock and the East Landfill

	Provide the City & County of Broomfield with the basis to no longer assume groundwater may be migrating through the fractures in the weathered bedrock and potentially migrating around No Name Gulch. Conflicting information states the PU&D Yard groundwater plums shows evidence of methane that could have migrated from the Present Landfill along a fracture zone. If methane is migrating to additional groundwater wells from the landfill, the proposed plan should identify and include any wells that exist along the fracture zone and these wells should be included in the groundwater network.	Pond dam construction into the unweathered bedrock, preferential goundwater flow paths do not exist. As shown in the integrated model; groundwater within the landfill discharges through the existing seep. The 2000 Annual RFCA Groundwater Monitoring Report indicates in the plume degradation monitoring section, that well 02097 detected 17,000 ug/L of methane. This sample result was collected in 2001 and both the 2000 and 2001 annual reports indicate that additional sampling and analysis should be conducted to verify this high methane value. Methane is a degradation product associated with various organic compounds. It is believed that this high concentration is the result of the degradation associated with the treatability study being conducted at the PU&D yard. However, additional research has been done to determine if this high concentration of methane can be verified through additional sampling and analysis. In March 2002, a sample was collected for methane analysis at well 02097 and results were 370 ug/L. A laboratory qualifier indicated that the concentration of this compound exceeded the calibration range. In July 2002, an additional sample was collected and results indicate a concentration of methane at 500 ug/L. In 2003, two additional samples were collected for methane analysis. In January 2003 the methane results for well 02097 were 740 ug/L and in August 2003 the results were 35.1 ug/L. Prior to 2001, plume degradation monitoring was not conducted and methane analysis was not included in the analysis performed on well 02097. Although sampling and analysis of this well continues to show concentrations of methane to be present in well 02097, sampling and analysis has verified that a high methane concentration does not exist at well 02097. Methane concentrations detected in well 02097 are believed not to be associated with the Present Landfill. Any inferred fault within the Present Landfill lies beneath the waste fill material and waste fill material is located within a zone of saturation. It is not typical that gas generated within the landfill would travel downward through a zone of saturation and into an inferred fault. Methane gas generated within the landfill would typically rise above the zone of saturation and escape through a path of least resistance, such as a vent pipe located within the landfill. Since well 02097 is located within the PU&D yard plume, it is not recommended that this well be included in the Present Landfill RCRA groundwater monitoring system. Well 7187, located to the north of the Present Landfill and also

		along the path of the inferred fault zone, has not been sampled since 1995 and is scheduled for abandonment in 2004.
	The IM/IRA states monitoring wells that have been monitored over the last 18 years have shown that the landfill has not impacted downgradient groundwater quality. The evaluation does not address the interaction between groundwater plumes from the PU&D Yard and the landfill groundwater plumes. Broomfield continues to be concerned groundwater remediation is being evaluated in a fragmented process rather than holistically. Provide us with rational to determine there is no interaction between groundwater migration from the PU&D area and the landfill area.	As stated in Section 2.6.3, the groundwater monitoring program has never indicated a contaminated groundwater plume from the Present Landfill. The PU&D groundwater conditions are being evaluated in the Site-wide Groundwater IM/IRA. The modeling showed that it is possible that without the external GWIS drain operating, external groundwater (PUD yard plume) could enter the internal landfill drain, but would be routed towards the seep through the 5' thick gravel layer. It is not likely that landfill waters could migrate past the GWIS system and into external waters given the design of the 3-part GWIS system (i.e., external drain, clay barrier and internal landfill drain), regardless of whether or not the external GWIS drain was operational. This is further supported by the general structure of the landfill area that directs general groundwater flow in the landfill area in towards the landfill area due to the former hillside-stream morphometry.
	The groundwater intercept system was designed to discharge into the East Landfill Pond; however, data are unavailable to indicate whether this occurs. Last year the Site could not confirm if the intercept system was functioning per design. If the data are not available to determine if the intercept system is functioning per design, did the groundwater modeling assume failure of the system? Modeling involving the intercept system cannot be verified therefore modeling results cannot be compared with field measurements to determine if the cover is functioning per design. Broomfield questions the validity of the modeling. Provide us with the rational and justification of the cited wells pursuant to 40 CFR Subpart F. Several assumptions were made in the document, but were not substantiated, nor was the rational or data provided for the assumptions. We were informed last year that the slurry walls may not be functioning per design and the groundwater interception systems could be breached. Provide us with a path forward to determine if the intercept system is functioning per design. Are there any field tests that can be preformed to indicate if the slurry walls are breached? Based on the conceptual flow model for the landfill, there appears to be several uncertainties. How were the sensitivities addressed pertaining to the hydrologic flow uncertainties from impacts from surface water, infiltration from precipitation, fractured bedrock, unknown conditions of the groundwater intercept system, interaction with other contaminated groundwater plumes, impacts from major storm events, or erosion of the eastern side of landfill slope? Last year some data gaps were identified and had to be addressed for inputs into the modeling. Were the data gaps addressed and what additional information was obtained to provide sufficient data for the modeling and remedy selection?	As described in the modeling report, although the calibrated model assumed that the external GWIS drain was operational, a sensitivity analysis was performed to evaluate how the system responded without an operational GWIS drain. Results showed that heads increased slightly external to the landfill GWIS, but in general, simulated heads reproduced observed heads reasonably well without the external drain operating. In addition, the seep discharge also increased as a result of the increased gradient in towards the internal GWIS landfill drain which preferentially drains to the former western pond area and then to the seep. Either way, simulated heads, flow paths and seep discharge rates were similar for both cases. Therefore, the model results were generally not sensitive to whether this external drain is operational or not. Ultimately, it is likely that the external GWIS drain simply drains groundwater from areas of higher heads to areas along the GWIS where levels are lower, but never discharges into the non-perforated portion of the pipe. Field-testing that could be performed to test the performance of the slurry wall would include tracer tests and pump tests across the slurry wall. However, the integrated model and the data used in the model indicate that the slurry walls are performing. Several uncertainties were considered in the modeling as follows: 1) Surface water is limited and thus does not play an important role in the overall water budget. 2) Infiltration is a calculated system response. As such it is the parameter values that simulate infiltration that can be evaluated. These were not found to be as sensitive a model parameter as others and therefore only the porosity was evaluated. 3) The sensitivity of fractured bedrock permeability was evaluated (see Table 7-3). 4) Unknown conditions of the GWIS (i.e., Kh/Kv of GWIS landfill drain, Kh of

		landfill clay barrier, and Kh/Kv of GWIS external drain) were in fact evaluated. 5) Erosion was not part of the scope of the modeling, but is a consideration in the detailed design, 6) Transport was not part of the modeling scope since there is no contaminated groundwater to conduct a transport model, and 7) Major storm impacts were evaluated within the climate years tested, but not for 100 year basis. Generally, any data gaps are addressed through the sensitivity analysis performed in the integrated groundwater modeling.
	Water flows through the groundwater system and primarily discharges through seeps in this area. Per the document, "A second intermittent seep area exists north of SW097 on the hillside below the north asbestos disposal area. This seep only activates during significant precipitation events, and its flow is not monitored". When was the last time this seep was monitored? We believe there are two additional seeps besides the leachate seep at the landfill. If the above-mentioned seep is just below the north asbestos area, why is it not being monitored for asbestos when it is activated? Is this water being discharged to waters of the United States, or is it being captured in the Present Landfill Pond? If the seeps are being released, should they also be a source point and therefore be a point of compliance? Provide Broomfield with the rational and documentation to not monitor this seep if it is being discharged to the waters of the United States. Clarify what constituents a significant precipitation event.	One intermittent seep has been noted during historical sampling events at the Present Landfill. However, SW097 has historically been determined to be the primary seep emanating from the Present Landfill and as such, has been the focus of past and present monitoring activities. All seeps associated with the Present Landfill flow to either the passive seep interception and treatment system or to the East Landfill Pond. Construction of the RCRA equivalent subtitle C cover over the Present Landfill area will include those areas where intermittent seeps have existed in the past. As a result, intermittent seeps will no longer be present at the Present Landfill. Asbestos has not been included in past or present monitoring activities since asbestos is a mineral and the fibers of this mineral do not travel in groundwater.
	Broomfield's General Comments – Long-Term Stewardship Considerations	
	Information Management	
3	The City & County of Broomfield appreciates the efforts the Site has made to include aspects of long-term stewardship in the draft document. We understand this is a proposed accelerated action for the Present Landfill, but it is clear the proposed cover will be the final remedy for the landfill. We do not agree with the statement to defer long-term stewardship criteria to the Corrective Action Decision/Record of Decision (CAD/ROD). We therefore offer the following vision Broomfield has for long-term stewardship. We also identify weaknesses in the long-term stewardship proposal in the document. We expect to continue dialogue with the RFCA Parties to develop an enforceable Stewardship Plan to meet both your and our needs. The City and County of Broomfield supports continuing the use of the College Hill Library as the Rocky Flats official records management location. As a local government that performs additional analytical monitoring of surface water leaving Rocky Flats, we expect to continue "Quarterly Data Exchange" meetings to evaluate and discuss the conditions of the site post-closure as	This comment is beyond the scope of the Present Landfill IM/IRA. The RFCA Parties are currently negotiating modifications to RFCA to address the post closure period.

	information is being disseminated. Adequate and timely information regarding the impact of RFETS is necessary to reassure residents their environment is safe. Broomfield will like to continue hosting the meeting with the RFCA Parties and other local governments. We not only plan to discuss the analytical data, but to work collaboratively with the Parties as we have in the past and are currently working with them when information is being exchanged. The Water Working Group meetings and the Integrated Monitoring Plan (IMP) meetings have served as a valuable tool to provide information to all parties performing analytical sampling of environmental media. The City and County of Broomfield also expects to have a post-IMP to continue the level of communication between all parties performing analytical sampling of surface water and/or air monitoring. With closure of the site potentially occurring within the next two years, we would like to work with the RFCA Parties and Legacy Management as soon as possible to draft an Information Management Plan to meet the needs of asset holders post-closure. Broomfield would like to discuss what documents they would like to have hard copies of and what information can be provided electronically. We would also expect to see the same process for pond discharges continue post-closure so that our sampling can coincide with DOE's and the State's sampling events. As a minimum we would expect to see: • Quarterly Reports of sampling performed on a quarterly basis (all media) • Annual Groundwater Report to evaluate the groundwater hydrology and contamination levels of the groundwater plumes, and status of the groundwater network • Reports of Groundwater Treatment Units • Site-wide Annual Status Report • Ecological Reports • Air Monitoring Reports • Administrative Record • Standard Operating Procedures • Sampling and Analysis Plans • Contingency Plans • Surveillance and Monitoring Reports • Contact Information for DOE as a controlling authority	
	Periodic Reviews	
4	The City and County of Broomfield would like to have "Periodic Reviews" every three years until as such a time it is determined sufficient data is available to warrant a longer periodic review schedule. We realize it will take 3-7 years for vegetation to fully mature at the site after remediation occurs and we are concerned without mature vegetation, there is a potential for actinide	This comment is beyond the scope of the Present Landfill IM/IRA. The RFCA Parties are currently negotiating modifications to RFCA to address the post closure period.

	migration. We are not requesting a three-year schedule for the life of the contaminant, but rather a more constricted time frame for at least the first 10 years to evaluate the functionality of the newer remedies, maturity of the vegetation, and potential for major changes in the water balance at the site. Once again the City and County of Broomfield offers support from staff to assist with drafting the foundation of the periodic review. The Site previously had a 5-year review and it was lacking in information Broomfield expected to have included in such an important review document. Please refer to our comments and/or concerns provided for the past 5-year review the Site performed. Once again, as asset holders and as a potential impacted community, we would like to attend the walk-down of the site during the physical review inspections.	
	Controlling Authority	
	DOE is to be the controlling authority responsible for any lands containing residual contamination. A DOE presence should be at the site in the event of a major storm event, implementation of a contingency, or in the event of a grass fire. As in the past, we would continue to meet with DOE and the other RFCA parties within 24 hours in the event of an emergency.	This comment is beyond the scope of the Present Landfill IM/IRA. The RFCA Parties are currently negotiating modifications to RFCA to address the post closure period.
	Institutional Controls	
;	We reiterate we support the State's Environmental Covenants Law in the Colorado Revised Statues §25-15-317 to 327. The Covenants Bill would serve as an additional layering tool in the event a single control failed. We support having the State in an enforceable role post-closure to provide oversight of activities associated with areas containing residual contamination. The State has always been an ally to ensure our concerns have been addressed and we wish to continue this rapport with the State.	The RFCA Parties are discussing the applicability of this statute to the federal government. Additionally, the proposed action for the Present Landfill presented in the IM/IRA is an accelerated action under RFCA; therefore, the Environmental Covenants Law is currently not considered an ARAR for the Present Landfill. Also, this comment is beyond the scope of the Present Landfill IM/IRA. The RFCA Parties are currently negotiating modifications to RFCA to address the post closure period.
7	The physical and institutional controls are merely addressed in Table 7 of the document. Once again if this is the final remedy, the specifics of the anticipated physical and institutional controls that are part of the remedy and how they are implemented should be identified in the IM/IRA. We understand closure is near and both the physical and institutional controls need to be identified now rather than later.	Section 5.0 et al. identifies the engineered controls, including inspection and reporting requirements and frequencies, which will be implemented for the proposed action. Appendix A identifies the institutional controls, including inspection and reporting requirements and frequencies, which will be implemented for the proposed action.
8	We support a fence around the Industrial Area and any area with residual contamination to secure the area and prevent access by the public. We want to maintain the integrity of the monitoring stations, treatments units, holding ponds, and covers. Our intent is not to generate a negative atmosphere, but to prevent access to areas where the public may wander into out of interest and potentially not adhering to an institutional control. The Present Landfill	Institutional and engineered controls as described in the IM/IRA (See Appendix A) are proposed to control access to the site. A fence is currently proposed to surround the entire facility to control access.

	already has a fence surrounding the boundaries of the IHSS, and we intend to have a fence remain around the landfill to prevent intrusion or vandalism of the cover, monitoring points of compliance, and the Eastern Landfill holding pond.	
	Monitoring and Maintenance	
	Monitoring: The City & County of Broomfield does not agree with the proposal *to monitor the groundwater monitoring wells semi-annually for two years after the cover is installed*. We do not know the effect of the new cover on surface water quality or groundwater quality. Provide the basis for the proposed two year monitoring regime. The decisions document does not address ecological impacts, nor are any action levels identified for ecological receptors. Revise the document to include action levels for receptors and identify the receptors. The Monitoring and Maintenance Manual should be drafted parallel with the design, not after the design to ensure S&M is performed once the cover is complete.	The monitoring period for groundwater at the Present Landfill will be identified initially as 30 years, recognizing that the regulatory agency may shorten this post-closure care period, if a reduced period is sufficient to protect human health and the environment. This evaluation will be conducted during the CERCLA periodic review period. During the initial groundwater-monitoring period, groundwater-monitoring wells will be sampled quarterly and summarized in annual reports. Ecological risk will be evaluated in the CRA and the site-wide RCRA Facility Investigation-Remedial Investigation/Corrective Measures Study-Feasibility Study (RI/FS). The Monitoring and Maintenance Manual will be drafted after the final detailed design document is completed.
	Groundwater	
	To propose to monitor only VOCs and metals is unacceptable based on information identifying hazardous substances, hazardous waste, or other contaminants placed in the landfill. If additional analytes are not monitored, how will slower migrating contaminants be evaluated after the two year sampling period? Without analyzing for additional analytes an evaluation of surface water or groundwater can not be performed in such a brief timeframe. Physical parameters such as pH and conductivity should also be measured. A drop in pH is an indicator something is occurring in the water. Once again, the City & County of Broomfield refers to RFCA and the IMP process. For years impacted local governments worked with the RFCA parties to determine data quality objectives and sampling regimes for all environmental media. Revise the document to reflect the current IMP, which includes Broomfield. The current process ensures the monitoring system will determine three things: 1.) the type of data to be collected, 2.) the methodology for determining the nature and extend of contamination and 3.) the effect on surface water.	The RFCA parties agreed, based on historical monitoring data for the seep, that VOCs and metals are good indicator parameters for changes in the seep water quality. If in the future statistically significant changes to the seep water quality are observed, the RFCA parties will evaluate if the monitoring program or the treatment system should be changed. As stated in the IM/IRA, a groundwater monitoring system was implemented under the IMP and contains a total of 8 RCRA wells (4 upgradient and 4 downgradient) for the Present Landfill. Monitoring of these wells will continue in accordance with this IM/IRA, which compares upgradient groundwater quality to downgradient groundwater quality. If concentrations at a downgradient well increase with time, it will be reported in accordance with the IM/IRA. In addition, the groundwater immediately downgradient of the East Landfill Pond will be evaluated in the RFETS Groundwater IM/IRA.
	Surface Water Landfill Seep	
1	The document states: After the cover is installed, monitoring at SW00196 will be conducted quarterly for two years. A validated exceedance of an effluent limit will trigger an increase in monitoring to monthly for three consecutive months. Continued exceedances during the three-month period will trigger consultation between the RFCA parties to evaluate whether a change to the remedy is required, additional parameters need to be analyzed or if a different	Appendix A describes the monitoring requirements for the seep. The text states that during the CERCLA periodic review, the RFCA Parties will evaluate whether continued monitoring is required after a proposed sampling period. The time frame itself does not mean that sampling could discontinue automatically. The evaluation will include a thorough data analysis.

	sampling frequency is required. If no exceedances are detected during the two-year period, then the monitoring frequency will change from quarterly to semi-annually for an additional two-year period. The document further states if there are exceedances in the following two years, the RFCA parties will determine a further evaluation. During the CERCLA periodic review, the RFCA Parties will evaluate whether continued monitoring at SW0096 is required. Once again the IMP process should be incorporated and include Broomfield in the evaluation. We question discontinuation of sampling during the review process without sufficient data. If seep water continues to be a point of compliance how can the Site justify not having a monitoring program to release the seep water to waters of the United States?	The text of the IM/IRA will be modified to present that seep monitoring will occur quarterly. The RFCA parties can adjust the frequency of sampling; however, based on the regulations, the monitoring frequency will be at least annually.
	Air Monitoring	
	Methane gas monitoring is not addressed. Clarify the monitoring criteria and plans for methane. Provide us with the sampling criteria or justification to discontinue methane air monitoring. Once again the cover may change the physical conditions of the waste and its decomposition. Gas vents are a necessary component of the cover and a requirement. Revise the document to include gas vents.	Gas vents were included in the proposed action as presented in Section 5, which will continue to vent any remaining generation of methane and act as barometric vents required for the geosynthetic type cover. Data collected at the existing vents indicate that the generation of methane is extremely small. Additionally, detailed calculations of methane will be included in the detailed design.
	Maintenance and Inspection	
;	Maintenance and Inspection: We are aware a section of the landfill already has some subsidence on the northeast side. To inspect the cover quarterly short-term is not sufficient. In the event of a major storm event, the cover may erode and will need to be inspected within 24 hours. Revise the document to reflect the cover is to be inspected within 24 hours of a major storm event. Until vegetation in the erosion areas such as the east slope area and the perimeter drainage ditches is mature, quarterly inspections are not sufficient. Revise the document to state monthly inspections will occur until vegetation is mature enough to ensure the potential for erosion has been greatly reduced. Table 7 implies repairs or corrective actions will take place in the event the criteria are not met. Provide the method to remove deep rooting trees without impacting the cover. How will the cover specification be assured during this corrective action process? Identify the timeframe to correct the identified deficiency. If burrowing animals are damaging the cover, what is the plan to prevent further intrusion by the animals? When weed control measures such as herbicides are used, we expect to be notified just as we are currently notified when the site is spraying for weed control. An approved list of the herbicide should be maintained and updated on an annual basis to ensure there will be no impact to surface water or groundwater quality. Include the details of the seep system and how the seep system will be inspected. The document proposes to discontinue monitoring of the seep with 2-4 years. Will the site continue to inspect the	The entire landfill (including the northeastern side) will be regraded to establish stable slopes. Monitoring of the erosion at the landfill after the action is completed will be conducted on a quarterly basis or as needed by site-specific conditions. The design of the accelerated action will provide detailed design drawings, specifications and quality control procedures for the construction of the cover. An independent QC company will monitor the construction of the cover and provide quality information for the closure certification report. Appendix A identifies the engineered controls, including inspection and reporting requirements and frequencies, which will be implemented for the proposed action. Details of maintenance and inspection will be included in the Maintenance and Monitoring Plan.

	inlet and outlet of the system? Will the outlet be inspected for effluent after a major storm event? A Surface Water Management Plan should be drafted to address surface water runoff from the cover and additional actions to be taken in the event of a major storm event.	
	The City & County of Broomfield wants to ensure the Present Landfill is secured and public access to the area in controlled by a fence. Revise the document language to reflect a fence will surround the landfill, associated seep treatment system, and east holding pond. Include the inspection criteria for routine inspections and inspections occurring after a major storm event.	Institutional and engineered controls as described in the IM/IRA (Appendix A) are proposed to control access to the site. A fence is currently proposed to surround the entire facility to control access.
	The Standard Operating Procedure, Sampling and Analysis Plan, and Surveillance and Maintenance Plan should also be incorporated into the IM/IRA. The document lacks the details of a Contingency Plan and as a minimal, parameters that would initiate a Contingency Plan should be identified within the proposed plan.	Appendix A identifies the monitoring, maintenance and inspection details for the proposed action and summarizes the Present Landfill post-accelerated action monitoring, maintenance, and institutional control requirements. Section 5.1 states that a monitoring and maintenance manual will be prepared after cover construction and will incorporate the regulatory requirements for inspection and maintenance of the cover and for groundwater monitoring as identified in the Appendix A of the IM/IRA. The development of a Contingency Plan is not a requirement of CERCLA or any ARAR identified in this IM/IRA. Effectiveness of the remedy will be evaluated during the CERCLA periodic review. Appropriate actions, if needed, will be taken on the basis of this review. No circumstances are currently envisioned that would necessitate a separate contingency plan for this action, above and beyond routine inspection and maintenance, and the CERCLA periodic review.

City of Westminster Comments
Draft Interim Measure/Interim Remedial Action (IM/IRA)
for Operable Unit 7 (IHSS 114) and RCRA Closure of the RFETS Present Landfill

Comment No. (Ref)	Comment	Response
	General comments:	
1	1. There are certain sections of the present document that seem to skim over or delete entire sections that were present in the previous IM/IRA. This makes the present document seem to be less detailed and arranged so as to justify the proposed remedy. The missing sections need to be placed back into this IM/IRA. See specific comments for information.	The DOE believes that the IM/IRA contains sufficient information to describe the basis for the proposed actions. See responses to specific comments below.
2	2. Last year, we participated in a trip to Sandia National Laboratories to see their Alternative Landfill Technology test beds and to discuss the different alternative covers with Dr. Steve Dwyer. The following are quotes from "Alternative Landfill Cover *Subsurface Contaminants Focus Area and Characterization, Monitoring, and Sensor Technology Crosscutting Program*" December 2002 by Dr. Stephen Dwyer, Sandia National Laboratories: "**GCL Alternative Cover** -- This cover did not perform as well as expected. It is possible that as moisture moves through the geomembrane (either through defects or diffusion), it runs through the seams of the GCL before the seams can hydrate and swell shut. The GCL could also have been damaged during construction, the bentonite could be leaching from it, or it could have been damaged by root intrusion." "Evapotranspiration **Soil Cover** -- This cover is performing well, with observed percolation rates that are comparable to the RCRA Subtitle C Cover." The data from Sandia's tests and discussions with Dr. Dwyer support the use of an ET cover, which is better suited to our climatic conditions than a GCL cover. In addition, there was considerable time and effort put forth by RFETS to convince us that an evapotranspiration cover was the best-suited alternative for the landfill. Furthermore, it is unclear from the document whether an analysis was ever conducted that fully weighs the	The proposed cover for the Present Landfill employs a GCL along with other components. The other components as described in Section 5 of the IM/IRA include a flexible membrane liner (FML) under a geocomposite drainage net (GDN). The FML will be installed under strict specifications with independent QC and testing of the seams. The role of the GDN is to drain water from the top of the FML to prevent any build up of vertical water head on the FML (removes the driving force of water through the FML). Additionally, the subgrade of the landfill cover will be carefully graded to remove protrusions that might puncture or damage the GCL or the FML just prior to its placement. Roots from the vegetation above the geosynthetic liner are not expected to ever reach the GCL since the FML will act as an effective rooting barrier. The evaluation of the cover alternatives considers the overall short-term and long term impacts of the action. The long-term maintenance requirements of the proposed action are generally less than the short term negative impacts of the ET cover. Section 4.0 of the IM/IRA specifically discusses and calculates the additional safety risks associated with the construction of an ET cover. Clearly, the additional vehicle-miles required to build the ET cover and the associated accident rates is less for the proposed geosynthetic cover alternative which uses more readily available materials located closer to the RFTES facility.

	short-term risk of installing an ET cover versus the long-term cost and maintenance of a GCL cover. We believe that the current IM/IRA does not convincingly analyze or defend the use of a GCL cover over that of an ET cover.	
	3. I consulted with the FWS at Rocky Mountain Arsenal on the types of RCRA covers they are placing at RMA: Steve Garland, a design engineer for Foster Wheeler- Tetra Tech, who is designing two of the covers provided the following information, "There are two hazardous waste landfills designated to be constructed at the Rocky Mountain Arsenal each with specially designed RCRA Subtitle "C" Final Covers capable of accommodating a 1000- year frequency design storm. Both final covers have a similar long life design consisting of a 1-ft thick rock-amended vegetative soil layer underlain by a 4-ft thick water storage layer, a 1.5-ft thick recycled concrete or rock biota barrier layer, a cushion geotextile, a 60-mil high density polyethylene geomembrane, a geosynthetic clay liner, a 0.5-ft granular stone pressure relief layer and a filter geotextile. The rock-amended vegetative soil layers are specially designed to mitigate long term erosion of the cover system and the storm water drainage control systems are designed to be self-cleaning to minimize post-closure maintenance." In addition, Lou Greer, a Project Engineer from Washington Group, who is designing the remaining covers at the Arsenal, responded: "RCRA-equivalent covers will be constructed at five sites encompassing over 400 acres at the Rocky Mountain Arsenal (RMA). These "alternative landfill covers" have met Record of Decision (ROD)-equivalency criteria by being successfully tested with computer simulation and field demonstration, and will now be used for full-scale implementation projects to minimize or eliminate percolation of water through the cover into waste materials. The covers work on the principal of "envapotranspiration (ET)" where the soil layer acts as a sponge to hold moisture, which is then removed (transpired) by the vegetation. ET covers are particularly well suited for the Denver climate, and will provide a natural cover system for the future wildlife refuge. The field demonstration project consisted of four test covers built of two different soil types (based on grain-size distribution) with cover thickness of 42, 48, and 60 inches. The final design is anticipated to consist of (from top to bottom) 6-inch soil layer for	The proposed cover configuration has been modified above the geosynthetic liner to provide a vegetative cover (See attached cover cross-section). The new hazardous waste landfills at RMA are quite different from the Present Landfill and are being constructed to accept what is essentially newly generated hazardous waste from cleanup of other portions of RMA. The Present Landfill received primarily sanitary, solid wastes including office trash, paper, rags, personal protective equipment, construction and demolition debris, scrap metal, empty waste containers, used filters, and electrical components. Some wastes with hazardous constituents were disposed, but consisted of the types of wastes commonly found in municipal landfills. Waste with hazardous constituents ceased to be disposed of in the landfill by the fall of 1986 by tightening administrative controls prior to it ceasing operations in 1998. The Present Landfill has also had little to no environmental impact on the soils and groundwater at the landfill. The seep at the eastern edge of the landfill is considered to be mostly groundwater and water that infiltrates through the landfill wastes and has very limited contamination of benzene and vinyl chloride. It is clear that RMA believes that on-site borrow areas will provide sufficient quality soils for the RMA proposed ET covers. This is not the case at RFETS, and soils would have to be transported via public highways from many miles away. The long-term maintenance requirements of the proposed action are generally less than the short term negative impacts of the ET cover.

	erosion/settlement, 42-inch ET soil layer, 18 inches biota barrier, and variable thickness of grade fill to attain proper drainage configurations. Soils acceptable for cover construction will be defined on a soil texture triangle, and mapped according to the results of borrow area characterization testing. The pre-construction borrow characterization will constitute most, if not all, of the QC testing program. QA testing will be conducted during construction to verify the acceptability of placed cover soils. A program of inspections and monitoring procedures will accomplish long-term care of the covers. Repairs will be made as necessary to maintain the covers according to design objectives. Pan lysimeters will be placed in various areas of the covers to verify that any deep percolation is less than the target performance criterion of 1.3 millimeters per year (mm/yr)." These proposed covers seem to be much more robust than what is described in the IM/IRA. The proposal to install a Resource Conservation and Recovery Act (RCRA) cover instead of the initial proposed envapotranspiration (ET) cover may have some long-term stewardship ramifications that were not addressed in the revised document during the alternative analysis. I would like to see the analysis that was performed for the Present Landfill and the parameters that were used to determine the proposed remedy.	
	4. Has the salt content of the soil been analyzed? According to an article in the *Journal of Geotechnical & Geoenvironmental Engineering* (January 2000), entitled "Effect of Wet-Dry Cycling on Swelling and Hydraulic Conductivity of GCLs" by Ling-Chu Lin and Craig H. Benson: "Atterberg limits, free swell, and hydraulic conductivity tests were conducted to assess how wet-dry cycling affects the plasticity and swell of bentonite, and the hydraulic conductivity of geosynthetic clay liners (GCLs) hydrated with deionized (DI) water (pH 6.5), tap water (pH 6.8), and 0.0125-M $CaCl_2$ solution (pH 6.2). The plasticity of bentonite hydrated with DI water increased during each wetting cycle, whereas the plasticity of bentonite hydrated with tap water and $CaCl_2$ decreased during each wetting cycle. Wet-dry cycling in DI water and tap water had little effect on swelling of the bentonite, even after seven wet-dry cycles. However, swelling decreased dramatically after two wetting cycles with $CaCl_2$ solution. Hydraulic conductivity of GCL specimens remained low during	**The specific salt content of the soil has not been analyzed; however, the GCL will not be exposed to a continual wet-dry cycle as in these experiments. The GCL is covered with a flexible membrane liner (FML). Hydration of the GCL is expected to be from soil moisture with the cushion layer under the FML and very limited to no infiltration of moisture through the FML (pinhole infiltration).**

	the first four wetting cycles (~1 × 10^{-9} cm/s). However, within five to eight cycles, the hydraulic conductivity of all specimens permeated with the 0.0125-M $CaCl_2$ solution increased dramatically, to as high as 7.6 × 10^{-6} cm/s. The hydraulic conductivity increased because cracks, formed during desiccation, did not fully heal when the bentonite rehydrated. In contrast, a specimen continuously permeated for 10 months with the 0.0125-M $CaCl_2$ solution had low hydraulic conductivity (~1 × 10^{-9} cm/s), even after eight pore volumes of flow."	
	5. A cobble only surface may allow for plants that normally don't grow in the area (i.e., trees, deep-rooted shrubs) to grow there. Would it not be better to have a top layer of cobble and native soil to allow for any natural revegetation of native plants and prevent the intrusives?	The proposed cover configuration has been modified above the geosynthetic liner to provide a vegetative cover (See attached cover cross-section).
	6. In drought conditions, sodium bentonite has the potential to hold water better than the surrounding soil. What will keep any plant roots from seeking this moisture?	The GCL (bentonite) layer is covered by a flexible membrane liner (FML) that will not allow the intrusion of plant roots.
	7. If organics are present, then some membranes may degrade fairly quickly, so chemical compatibility between the membrane and contaminants needs to be analyzed and determined before installation.	The wastes in the landfill are currently covered by about 3 feet of soil. The subgrade preparation before the geosynthetic liner is placed, will be covered with at least 6-inches of silty soil. Therefore the lining materials will not be in contact with any waste materials. Further, historical soil gas sampling has not shown any high concentrations of organic constituents in the landfill gas to cause degradation of the liner materials. In addition, the materials of construction have been tested by manufacturers and are known to be adequately resistant to degradation from the types of organic compounds disposed in the Present Landfill. The design will include chemical compatibility criteria to optimize the selection of specific components.
	8. A contingency plan for any degradation or failure of the cover is required as part of this IM/IRA. Failure of the remedy would require implementation of a contingency plan. The plan should include data quality objectives (DQOs) to determine if the remedy is functioning per design. Implementation of the plan should include an evaluation of the data and/or corrective actions to ensure the remedy DQOs are being met and the cap is functioning per design. The non-routine corrective actions taken during the contingency phase will have to meet specific specifications when items are being repaired or replaced.	The proposed accelerated action is to implement the CERCLA presumptive remedy of source containment. Source containment for a landfill is presumptively the most appropriate based on historical patterns of remedy selection and on EPA's scientific and engineering evaluation of performance data on implementing such a cover over a landfill. RCRA interim status closure performance standards have been identified as ARARs in Appendix E and includes A RCRA subtitle C cover for this landfill. A RCRA subtitle C cover is designed and constructed to minimize infiltration through the cover, promote drainage, function with minimal maintenance, accommodate settling and have a permeability less than the existing subsoils

		present beneath the landfill. As specified within these regulatory requirements, compliance with RCRA Subtitle C design standards ensures that a facility is closed in a manner that is protective of human health and the environment. As described in Section 5.1 a monitoring and maintenance manual will be prepared after cover construction and this manual will incorporate the regulatory requirements for inspection and maintenance of the cover, as identified in Appendix A. A contingency plan for failure of a presumptive remedy is not a regulatory requirement. Degradation of the cover surface, which could indicate subsurface cover component damage, will be evaluated based upon routine inspections. Repairs will be made as necessary for the continuing effectiveness and protectiveness of the cover. A contingency plan for failure or degradation of a cover is not a regulatory requirement.
	9. There is no discussion on the use of lysimeters. A means of identifying any movement of moisture or water through the landfill needs to be included in the IM/IRA.	The geosynthetic composite cover proposed for the landfill is a robust multilayer cover with component design specifications based upon limiting infiltration to less than 1.3 mm/year. Because the cover will be constructed in accordance with these specifications, lysimeters or other seepage measurements under the cover are not required.
	Specific comments:	
0	<u>Page 36, top of page</u> Add the following after the fourth bullet: • Control any remaining sources of groundwater contamination to the extent necessary to prevent enlarging the plume or increasing contaminant concentrations. Engineered covers are the presumptive remedy for CERCLA municipal landfill sites (EPA 1993). Such containment technologies are generally appropriate for municipal landfills because the waste poses a relatively low long-term threat to public health and the environment, and the volume and heterogeneity of the waste make treatment impractical. Although the majority of waste disposed in the Present Landfill is considered municipal waste, some hazardous wastes were buried there and	As stated in Section 2.6.3., the groundwater monitoring program has never indicated a contaminated groundwater plume from the Present Landfill. In addition, 18 years of groundwater monitoring has indicated that the Present Landfill has not impacted downgradient groundwater quality, without a RCRA Subtitle C compliant cover placed over the landfill. Therefore, a groundwater remedial action objective (RAO) was not identified since the landfill is currently not impacting groundwater quality. By design a RCRA subtitle C equivalent cover will significantly reduce infiltration through the landfill and provide an overall positive impact to groundwater quality. All pathways are addressed in this IM/IRA for containment as the presumptive remedy. Section 5.1 addresses the landfill, landfill cover and landfill gas as part of the proposed action. Section 5.3 addresses the seep water, and section 5.4 and

	hazardous components have been detected in the leachate. As a result, the specific criteria used for the landfill cover design are based on a RCRA Subtitle C facility. The containment presumptive remedy consists of the following elements: • Landfill; • Landfill gas control and treatment, if required; • Leachate collection and treatment; • Source area groundwater control to minimize the plume; • Institutional controls to supplement engineered controls The containment presumptive remedy addresses all pathways associated with the source.	Appendix A addresses institutional controls that are protective and address short and long-term effectiveness. Maintenance and monitoring of the groundwater monitoring system is addressed in Appendix A. Source area groundwater controls were implemented in the 1970's and included a groundwater collection system, a groundwater intercept system, and the installation of slurry walls. This information is provided in Section 2.2.
	Table 5, page 41 Why is this table different than the one in the former proposed IM/IRA? Should it not be the same except for the inclusion of the GCL analysis?	The table was revised to include all the geosynthetic components suggested by the most recent EPA guidance for the design and installation of RCRA Subtitle C compliant covers. The table was also revised to include the soil only cover.
!	Section 5.1, Landfill Cover, page 53 On page 35, it states, "Model results indicated relatively low rates of landfill gas generation, with majority (approximately 80 percent) of methane and total landfill gas production occurring by the year 2025, and almost all potential production occurring by the year 2075 (K-H 2002b)." On Page 53, it states, "These vents will be removed before placement of the cover, and may be replaced with barometric vents as determined by the detailed engineering design." If gas is going to continue to be produced through 2025 and possibly up to 2075, a gas venting mechanism needs to be detailed in the IM/IRA.	Because of the low rates of gas production, landfill gas is not a hazard that must be addressed in this action. The existing vents will be removed. New vents will be designed and installed as a part of the proposed cover configuration. The vents primary purpose will be to provide barometric venting required for covers with an FML; however, it will also vent any further methane production from the landfill.
3	Sections detailing the following topics that were included in the previous IM/IRA need to be placed back into the present document: Section 5.1, Project Planning & Execution Section 5.2, Mobilization Section 5.3, Site Preparation Also, add the following sections that were in the previous IM/IRA:	The suggested sections 5.1, 5.2, 5.3,5.7 and 5.8 are basically administrative and are appropriate for the detailed design and contract documents for construction (design drawings and construction specifications and special conditions), and not needed in the IM/IRA, which provides the basis for the proposed response action for the landfill. See response to comment 14 for language that will be added to the IM/IRA, which addresses some key aspects of this comment.

	Section 5.5, Performance Monitoring Equipment Section 5.7, Readiness Determination Section 5.8, Quality Assurance Your section 5.2 becomes Section 5.9. Your Section 5.3 becomes Section 5.10. Your Section 5.3.1 becomes Section 5.10.1 Your Section 5.3.2 becomes Section 5.10.2	If the suggested Section 5.5 relates to post-action monitoring, post action monitoring is included in Appendix A of the IM/IRA. Details of post-action monitoring will be in the Monitoring and Maintenance Plan prepared after the design is completed.

Section 6.1, Page 59 After the third bullet, add the following: This IM/IRA serves as notification to CDPHE of the pending closure of the Present Landfill. No specific form is required for notification of closure. The overall project approach is presented in Section 5. Detailed design specifications will be presented in the final design documents. The construction contractor will be held in strict conformance to the final construction design drawings and specifications. QA/QC inspection and testing will be performed during construction of the cover in accordance with the CQC Plan that outlines specific inspection and testing requirements for all materials and construction performance, necessary documentation, procedures for correcting nonconforming items, and the party responsible for each aspect of CQC. All materials and placement of materials for the cover will be subject to inspection and testing to assure conformance to the specifications. Ancillary activities performed concurrently with construction of the cover will include wetlands mitigation, surface water management, and site security. Compensatory mitigation for unavoidable impacts to wetlands will be provided in accordance with the applicable or relevant and appropriate requirements (ARARs). Grading the surface of the landfill will control surface water run-off. Surface water will drain to the perimeter drainage ditches and routed to No Name Gulch. The water level in the East Landfill Pond will be lowered to allow better access for construction activities during closure and to allow for removal of the East Landfill Pond dam by transferring water to the "A" series Ponds. Leachate management and landfill gas monitoring will be performed as a continuation of the accelerated action until construction of the cover begins. Site security will be maintained during and after construction activities. A chain-link fence surrounds the Present Landfill, prohibiting access by unauthorized personnel. Gates will be installed for construction access.	The following sentences will be added to the 1st paragraph under Section 6.1, after the first sentence, "This section of the IM/IRA is the Closure Plan for the Present Landfill and this IM/IRA serves as notification to CDPHE of the pending closure of the Present Landfill. No specific form is required for notification of closure. A new section 6.1.4 will be added, titled "Closure Activities": "The overall project approach is presented in Section 5. Detailed design specifications will be presented in the final design documents. The construction contractor will be held in strict conformance to the final construction design drawings and specifications. QA/QC inspection and testing will be performed during construction of the RCRA equivalent Subtitle C cover in accordance with the Construction Quality Control (CQC) Plan as well as the construction specifications that outlines specific inspection and testing requirements for all materials and construction performance, necessary documentation, procedures for correcting nonconforming items, and the party responsible for each aspect of the CQC. All materials and placement of materials for the cover will be subject to inspection and testing to ensure conformance to the specifications. Ancillary activities performed concurrently with construction of the RCRA equivalent Subtitle C cover will include wetlands protection, surface water management, and site security. Compensatory mitigation for unavoidable impacts to wetlands will be provided in accordance with ARARs. Surface water run-off will be controlled by grading the surface of the landfill. Surface water will drain to the perimeter drainage ditches and routed to No Name Gulch. The water level in the East Landfill Pond may be lowered to allow better access for construction activities during closure by transferring water to Pond A-3. Seep management and landfill gas monitoring will be performed as a continuation of the accelerated action until construction of the cover begins. Site security will be maintained during and after construction activities. Signs will be posted warning of potential danger at the landfill." A new section 6.1.5 will be added, titled " Closure Certification": "After installation of the RCRA equivalent Subtitle C cover, DOE will provide CDPHE with a certification that the Present Landfill cover has been installed in accordance with the final, approved design documents (including approved changes and field modifications, if applicable). An independent, registered, professional engineer will sign this certification."

	Signs will be posted warning of potential danger at the landfill. Within 60 days following installation of the cover, DOE will provide CDPHE with a certification that the Present Landfill has been closed in accordance with the final, approved design documents. This certification will be signed by an independent, registered, professional engineer. The closure certification and supporting documentation will be included in the Closeout Report, as described in Section 10.0.	
;	Section 6.2, page 61 *"...Post-closure care requirements are implemented pursuant to a Corrective Action Decision/Record of Decision (CAD/ROD)".* Since the proposed action is a final remedy, the IM/IRA shall capture ALL the elements of post-closure care. Detail these requirements in Section 8.	Appendix A discusses compliance with the Post Closure Care requirements and as stated in Section 5.1., a Maintenance and Monitoring Manual will be created once construction of the cover is completed. Details of post-closure maintenance and monitoring will be identified in this manual.
;	<u>Section 6.2.2.3.2 Maintain and Monitor the Groundwater Monitoring System, Page 62</u> The IM/IRA states *monitoring wells that have been monitored over the last 18 years have shown that the landfill has not impacted downgradient groundwater quality.* The evaluation does not address the interaction between groundwater plumes from the PU&D Yard and the landfill groundwater plumes. Westminster continues to be concerned groundwater remediation is being evaluated in a fragmented process rather than holistically. Provide us with rational to determine there is no interaction between groundwater migration from the PU&D area and the landfill area. *The groundwater intercept system was designed to discharge into the East Landfill Pond; however, data are unavailable to indicate whether this occurs.* Last year the Site could not confirm if the intercept system was functioning per design. If the data are not available to determine if the intercept system is functioning per design, did the groundwater modeling assume failure of the system? Modeling involving the intercept system cannot be verified	As stated in Section 2.6.3., the groundwater monitoring program has never indicated a contaminated groundwater plume from the Present Landfill. Modeling has shown that it is possible, without the external GWIS drain operating, that external groundwater (PU&D yard plume) could enter the internal landfill drain, but would be routed towards the seep through the 5' thick gravel layer. It is not likely that landfill waters could migrate past the GWIS system and into external waters given the design of the 3-part GWIS system (i.e., external drain, clay barrier and internal landfill drain), regardless of whether or not the external GWIS drain was operational. This is further supported by the general structure of the landfill area that directs general groundwater flow in the landfill area in towards the landfill area due to the former hillside-stream morphometry. The GWIS system wasn't just designed to discharge to the east landfill pond. (See Conceptual Figure) It also was designed to discharge to the former west pond and downstream of the dam to no-name gulch. The integrated flow modeling considered two cases; one case assumed the drain operates, but the drain discharge was simply removed from the model (i.e., does not impact water balance of the pond, or downgradient of the dam), and the second case where the external drain is not functional. This is included in the

	therefore modeling results cannot be compared with field measurements to determine if the cover is functioning per design. Westminster questions the validity of the modeling. Several assumptions were made in the document, but were not substantiated, nor was the rational or data provided for the assumptions. We were informed last year that the slurry walls may not be functioning per design and the groundwater interception systems could be breached. Provide us with a path forward to determine if the intercept system is functioning per design. Are there any field tests that can be preformed to indicate if the slurry walls are breached? Based on the conceptual flow model for the landfill, there appears to be several uncertainties. How were the sensitivities addressed pertaining to the hydrologic flow uncertainties from impacts from surface water, infiltration from precipitation, fractured bedrock, unknown conditions of the groundwater intercept system, interaction with other contaminated groundwater plumes, impacts from major storm events, or erosion of the eastern side of landfill slope? Last year some data gaps were identified and had to be addressed for inputs into the modeling. Were the data gaps addressed and what additional information was obtained to provide sufficient data for the modeling and remedy selection?	report in Appendix C. Results showed that major conclusions about flow directions/pathways and the water balance of major landfill features do not change significantly. Additionally, groundwater levels in wells within the model area, even near the trench are reproduced reasonably well for both cases. In the case where the external drain is not functional, heads increase slightly external to the landfill trench and the seep flow increases slightly due to the increased hydraulic gradient from outside the waste to inside the waste (and into the internal landfill drain that preferentially routes water to the former western pond and eventually out the seep). It is important to recognize that the even if the external drain fails (possibly simply redistributes groundwater from higher head areas to lower head areas prior to reaching the non-perforated pipe), the outside sand bed it was emplaced in extends from the groundsurface to the bottom of the outside of the trench and will also tend to redistribute (equilibrate) groundwater outside of the trench such that areas with higher water levels drop and areas with lower levels increase. Available data suggest that groundwater levels are well above the bottom of the landfill trench over its entire extent (at least where data are present). Field tests (hydraulic testing – pump testing, tracer testing, or further geochemical fingerprinting) could be performed to evaluate slurry walls, or the landfill trench. As described in the modeling report, although the calibrated model assumed that the external GWIS drain was operational, a sensitivity analysis was performed to evaluate how the system responded without an operational GWIS drain. Results showed that heads increased slightly external to the landfill GWIS, but in general, simulated heads reproduced observed heads reasonably well without the external drain operating. In addition, the seep discharge also increased as a result of the increased gradient in towards the internal GWIS landfill drain which preferentially drains to the former western pond area and then to the seep. Either way, simulated heads, flow paths and seep discharge rates were similar for both cases. Therefore, the model results were generally not sensitive to whether this external drain is operational or not. Ultimately, it is likely that the external GWIS drain simply drains groundwater from areas of higher heads to areas along the GWIS where levels are lower, but never discharges into the non-perforated portion of the pipe for whatever reason. Field-testing that could be performed to test the performance of the slurry wall would include tracer tests and pump tests across the slurry wall. However, the integrated model and the data used in the model indicate that the slurry walls are performing.

	Several uncertainties were considered in the modeling as follows: 1) Surface water is limited and thus does not play an important role in the overall water budget. 2) Infiltration is a calculated system response. As such it is the parameter values that simulate infiltration that can be evaluated. These were not found to be as sensitive a model parameter as others and therefore only the porosity was evaluated. 3) The sensitivity of fractured bedrock permeability was evaluated (see Table 7-3). 4) Unknown conditions of the GWIS (i.e., Kh/Kv of GWIS landfill drain, Kh of landfill clay barrier, and Kh/Kv of GWIS external drain) were in fact evaluated. 5) Erosion was not part of the scope of the modeling, but is a consideration in the detailed design, 6) Transport was not part of the modeling scope since there is no contaminated groundwater to conduct a transport model, and 7) Major storm impacts were evaluated within the climate years tested, but not for 100 year basis. Generally, any data gaps are addressed through the sensitivity analysis performed in the integrated groundwater modeling.
Water flows through the groundwater system and primarily discharges through seeps in this area. Per the document, "*A second intermittent seep area exists north of SW097 on the hillside below the north asbestos disposal area. This seep only activates during significant precipitation events, and its flow is not monitored*". When was the last time this seep was monitored? We believe there are two additional seeps besides the leachate seep at the landfill. If the above-mentioned seep is just below the north asbestos area, why is it not being monitored for asbestos when it is activated? Is this water being discharged to waters of the United States, or is it being captured in the Present Landfill Pond? If the seeps are being released, should they also be a source point and therefore be a point of compliance? Provide the City with the rational and documentation to not monitor this seep if it is being discharged to the waters of the United States. Clarify what constituents a significant precipitation event.	An intermittent seep has been noted during historical sampling events at the Present Landfill. However, SW097 has historically been determined to be the primary seep emanating from the Present Landfill and as such, has been the focus of past and present monitoring activities. All seeps associated with the Present Landfill flow to either the passive seep interception and treatment system or to the East Landfill Pond. Construction of the RCRA equivalent subtitle C cover over the Present Landfill area will include those areas where intermittent seeps have existed in the past. As a result, the intermittent seep will no longer be present at the Present Landfill. Asbestos has not been included in past or present monitoring activities since asbestos is a mineral and the fibers of this mineral do not travel in groundwater.
"*Monitoring of the existing RCRA groundwater monitoring wells will continue semi-annually for two years after the cover is installed.*" This statement appears elsewhere in the document as well.	The RCRA post-closure care period for the Present Landfill will be identified initially as 30 years, recognizing that the regulatory agency may shorten this post-closure care period, if a reduced period is sufficient to protect human health and the environment. This evaluation will be conducted during the CERCLA periodic review period. As stated in Appendix A, groundwater sampling results will be evaluated in accordance with RFCA Attachment 5, Section 3.0 for groundwater. DOE is

	The City does not concur with this proposed action. RCRA requires a 30-year monitoring period after remedy. The City supports that groundwater monitoring be continued through the 30-year period as required by RCRA. The standards are not identified in the document, thus there is no enforceability with the data. Without identified standards there are no corrective actions or penalties. The regulations and RFCA requires a DCL to be calculated on a unit-specific basis for the landfill and this was not done. If you used ACL's instead of DCLs, this was not done. RFCA states the POCs and ACLS will be designated within the appropriate decision document. RFCA also states all post-closure requirements, including monitoring, maintenance, access control, and security requirements, will be delineated in the Closure Plan, IM/IRA, or CAD/ROD decision document for the unit or waste management area. Since this is a final remedy this information needs to be included in Section 8 of the IM/IRA.	adhering to the requirements of RFCA pertaining to the Present Landfill. Section 6.2 discusses RFCA Attachment 10. RFCA Attachment 10 allows for the calculation of DCLs and ACLs, but does not require that DCLs or ACLs be calculated. The proposed and modified proposed cover is a cover equivalent to RCRA Subtitle C requirements. Neither proposal was based on DCL criterion, but rather upon a design infiltration rate that meets RCRA Subtitle C requirements and guidance criteria. Therefore, no DCLs are calculated. The conclusion of section 2.6.3 is that groundwater from the landfill is not impacting surface water quality. Therefore, no ACLs are calculated. The IM/IRA states that eight (four upgradient and four downgradient) RCRA groundwater monitoring wells have been established for the Present Landfill pursuant to RFCA and RCRA. Appendix A also states that the existing downgradient RCRA groundwater monitoring wells will be groundwater POC wells for RFCA Attachment 10. Changes in downgradient versus upgradient groundwater quality as measured at these wells will require consultation between the RFCA Parties to determine if changes to the remedy are required. This approach is consistent with the ARARs for closure of an interim status unit. The seep treatment system is part of the accelerated action and the treatment tank effluent is regulated under the IM/IRA. Appendix A describes the monitoring requirement, including effluent limits, for the seep treatment system. The NPDES outfall for the treatment system is at the point of discharge from the treatment tank. Post-closure care requirements are discussed in Appendix A. Appendix A identifies engineered controls, including inspection and reporting requirements and frequencies, which will be implemented for the proposed action. In addition, a Monitoring and Maintenance Manual will be drafted after the detailed design document is completed.
7	**Section 8.0, LONG-TERM STEWARDSHIP CONSIDERATIONS, page 76** Since the proposed action is a final remedy, this document shall capture all the elements of long-term stewardship. It needs to be detailed here, not in another document. *Information Management:*	Long-term stewardship considerations specific to the Present Landfill are identified in Appendix A. A summary of the Post-Accelerated Action Monitoring, Maintenance and Institutional Control Requirements based on, among other things, the long-term stewardship considerations is provided in a table within Appendix A.

	Westminster desires that DOE continue a document repository at the College Hill Library and work with local governments to determine which documents will be maintained. We do not support the use of any type of museum that may be created as the document repository. College Hill Library is centrally located and already utilized by our citizens. In addition to regular operational and performance monitoring, and maintenance of the remedies, the stakeholders must recognize that periodic reviews of remedies are required by CERCLA. The RFCA parties shall therefore commit to CERCLA reviews at a minimum of every three years for the first nine years following closure. At the end of the nine-year period, the periodic review shall be evaluated to determine the frequency of reviews. These reviews shall be conducted in accordance with the EPA's "Comprehensive Five-Year Review Guidance" and meet the information needs of the impacted local governments. Please refer to our comments and/or concerns provided in our letter dated May 22, 2002 to Reginald Tyler on the "Five-Year Review Report for Rocky Flats Environmental Technology Site dated April 2002". In this letter we detailed the information that we felt the document did not provide to meet the needs of the City. Also, quarterly stakeholder meetings will be held for the first three years after closure to provide updates on items such as: • Quarterly Reports of sampling performed on a quarterly basis (all media) • Annual Groundwater Report to evaluate the groundwater hydrology and contamination levels of the groundwater plumes, and status of the groundwater network • Reports of Groundwater Treatment Units • Site-wide Annual Status Report • Ecological Reports • Air Monitoring Reports • Administrative Record • Standard Operating Procedures • Sampling and Analysis Plans • Contingency Plans • Surveillance and Monitoring Reports • Contact Information for DOE as a controlling authority At the end of the three years, the periodicity and necessity of the meetings will be reexamined.	**Future information management criteria are beyond the scope of the Present Landfill IM/IRA. The RFCA parties are considering the information needs and requests of the community after the completion of accelerated actions and expect to address these needs after consultation with the community.**

	The City also expects to have a post-IMP to continue the level of communication between all parties performing analytical sampling of surface water and/or air monitoring. With closure of the site potentially occurring within the next two years, we would like to work with the RFCA Parties and Legacy Management as soon as possible to draft an Information Management Plan to meet the needs of asset holders post-closure. Westminster would like to discuss what documents they would like to have hard copies of and what information can be provided electronically.	Please see the response to comment 17, above.
	Controlling Authority:	
	DOE is to be the controlling authority responsible for any lands containing residual contamination. A DOE presence should be at the site in the event of a major storm event, implementation of a contingency, or in the event of a grass fire. As in the past, we would continue to meet with DOE and the other RFCA parties within 24 hours in the event of an emergency.	Appendix A states "DOE will retain jurisdiction over the engineered controls associated with the proposed action" and addresses DOE's responsibility as the controlling authority for the area covered by the proposed action. This comment is beyond the scope of the Present Landfill IM/IRA. The RFCA Parties are considering the needs and requests of all stakeholders after the completion of accelerated actions. The interest in specific continued presence of DOE personnel at RFETS, while noted, is beyond the scope of the Present Landfill IM/IRA.
	Engineered Controls:	
)	For every engineered control: What are the LTS implications of the control? How long is it expected to be in place? What maintenance, monitoring, etc. will need to be performed?	Appendix A identifies the engineered controls, including inspection and reporting requirements and frequencies, which will be implemented for the proposed action. Each engineered control will remain in place as long as necessary to protect human health and the environment. The long-term stewardship implication is that DOE will be responsible for the engineered control as long as necessary to protect human health and the environment.
	Institutional Controls	
1	For every institutional control: What are the LTS implications of the control? How long is it expected to be in place? What maintenance, monitoring, etc. will need to be performed?	Appendix A identifies the institutional controls, including inspection and reporting requirements and frequencies, which will be implemented for the proposed action. Each institutional control will remain in place as long as necessary to protect human health and the environment. The long-term stewardship implication is that DOE will be responsible for the institutional control as long as necessary to protect human health and the environment.
2	We again reiterate that the City supports the State's Environmental Covenants Bill. The Covenants Bill would serve as an additional layering tool in the event a single control failed. We support having the State in an enforceable role post-closure to provide oversight of activities associated	This comment is beyond the scope of the Present Landfill IM/IRA. However, the RFCA Parties are discussing the applicability of this statute to the federal government. Additionally, the proposed action for the Present Landfill presented in the IM/IRA is an accelerated action under RFCA; therefore, the Environmental

	with areas containing residual contamination. The State has always been an ally to ensure our concerns have been addressed and we wish to continue this rapport with the State. We support a fence around the Industrial Area and any area with residual contamination to secure the area and prevent access by the public and to prevent intrusion or vandalism of the cover, monitoring points of compliance, and the Eastern Landfill holding pond.	Covenants Law is currently not considered an ARAR for the Present Landfill. A fence around the Industrial Area is beyond the scope of the Present Landfill IM/IRA. A fence is not a part of the proposed action for the Present Landfill because public access will be controlled as a part of the use of the area as wildlife refuge.
	Additionally, there is a lack of monitoring, a lack of maintenance details, and a lack of inspection details. A detailed Contingency Plan is not identified. The EPA guidance for inspections for 5-year review and the inspection sheet(s) should be part of the document along with the SOPs, SAP, and O&M. All environmental monitoring needs detailed in this section as well.	The IM/IRA (See Appendix A) identifies the monitoring, maintenance and inspection details for the proposed action. Details of post-action monitoring and maintenance will be in the Present Landfill Monitoring and Maintenance Plan prepared after the design is completed. A contingency plan is not required for cover degradation or failure, however, appropriate actions to address items found during monitoring and maintenance will be taken. Effectiveness of the remedy will be evaluated during the CERCLA periodic review. Please see Appendix A for DOE's commitment on the CERCLA five-year review and the Present Landfill.
	Some additional comments:	
	Cover	

	1. Quarterly inspection of the cover is not sufficient for the first year because of the potential for settling and/or subsidence from the weight of the cap. The document states two feet will be used as a measure for the subsidence, but this will take the cap below the freeze line, thus jeopardizing the liner and the integrity of the cap. The City supports that six-inches are used as a measure for subsidence. What is the timeframe to repair the cap and how will the puddled water be managed if there is water ponding within the cap?	Monitoring of the erosion and subsidence at the landfill after the action is completed will be conducted on a quarterly basis or as needed based on weather conditions and previous inspection reports. Appendix A identifies the engineered controls, including inspection and reporting requirements and frequencies, which will be implemented for the proposed action including weed control. Details of maintenance and inspection will be included in the Maintenance and Monitoring Plan.
;	2. Weed controls: How will weeds be dealt with? If deep-rooted trees start to grow within the cap, how will they be removed and what are the criteria to ensure the cap has not been compromised. Corrective actions also have to have strong QA/QC protocols to ensure specifications are obtained to maintain the integrity of the cap.	See response to preceding comment above.
	Drainage Ditches	
5	1. Visual inspections should be performed monthly until vegetation has matured in the drainages ditches. Visual inspections should also be preformed after major storm events to insure there are no significant cracks or eroded areas.	Monitoring of the erosion and subsidence at the landfill after the action is completed will conducted on a quarterly basis or as needed based on weather conditions and previous inspection reports.
7	2. Weed controls: same issues as # 2 above.	See response to preceding comment above.
	Seep	
3	1. The Site's proposal to use the CERCLA exemption to discharge a hazardous waste in accordance with the National Pollutant Discharge Elimination System (NPDES) regulations is of concern. The leachate, which is currently a hazardous waste, is being released to a holding pond and then released to waters of the United States. Per the IM/IRA, the site proposes to use the wastewater "treatment unit exemption" to discharge the leachate as a new point source under NPDES. We understand the need to avoid overregulation of such units by requiring both regulations, but the criteria for the exemption is quite clear and the document does not address how the criteria will be adhered to, specifically treatment within a tank. Sampling needs to be performed monthly for at least the first two years to obtain sufficient data points to determine the performance of the remedy. A full suite of analytes should be taken annually until the first CERCLA review to evaluate the performance of the cap and obtain a baseline for the landfill once the remedy has been completed. Analytes under NDPES also have to be monitored for to meet the NPDES standard such as the WET	Section 6.4.3. describes the requirements for the RCRA wastewater treatment unit exclusion and how activities at the Present Landfill meet the requirements. The section has been revised for the final IM/IRA to state that treatment will occur in a tank. Final treatment details will be developed in the detailed design of the action. Appendix A describes the monitoring requirements for the seep. The text states that during the CERCLA periodic review, the RFCA parties will evaluate whether continued monitoring is required after a proposed sampling period. The time frame itself does not mean that sampling could discontinue automatically. The evaluation will include a thorough data analysis. The constituents currently associated with the Present Landfill seep and identified in this decision document are benzene and vinyl chloride. RFCA parties agreed, based on historical monitoring data for the seep, that good indicator parameters for changes in the seep water quality are VOCs and metals. If in the future statistically significant changes to the seep water quality are observed, the RFCA

	test, BOD, COD, and physical parameters for surface waters.	Parties will evaluate if the monitoring program or the treatment system should be changed. Monitoring of the seep is not performance monitoring of the cover. The cover is a presumptive remedy under CERCLA meeting RCRA Subtitle C requirements. A cover over a landfill has been determined to presumptively be the most appropriate based on historical patterns of remedy selection and on EPA's scientific and engineering evaluation of performance data on implementing such a cover over a landfill. The cover (a RCRA Subtitle C equivalent cover) is designed to minimize infiltration through the landfill and provide an overall positive impact to groundwater quality. A Whole Effluent Toxicity (WET) test, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) are not chemical specific standards for which stream standards exist. Instead these are a class of discharge conditions that may indicate an impact to a receiving water. There is no evidence of these conditions having an impact on the East Landfill Pond. In addition, it has been established that we do not have levels (in part per million or ppm) of any contaminant that would trigger these kind of conditions. RFETS believes that based on water quality for the Present Landfill seep and East Landfill Pond water, that BOD and COD would not be exerted at levels of environmental concern.
9	2. Enforceability is not identified in the document. If the water standard is exceeded are there any penalties? Where is the NPDES point source and is it considered a POC? I do not agree with the proposed point source, it should be at the release of the treatment tank. The point source and POCs should be identified. Under NPDES the point source needs to be identified. The groundwater wells are RCRA wells and the POCS should be identified along with the COCs. We know the cap is going to be the final remedy, thus we should know the regulatory compliance points and the enforceability of the monitoring stations. We have delayed LTS for other documents because we are not sure of the final land configuration or the status of the final water balance report. With the Present Landfill IM/IRA we know the slope of the area and the predicted water flow. I assume during the design of the cap, the contractor will also be drafting a SOP for the cap and the associated O&M of the IHSS. The document does not state this, nor does it identify a SOP.	The seep treatment system is part of the accelerated action and the treatment tank effluent is regulated under the IM/IRA. Appendix A identifies the monitoring requirements to determine seep treatment system effectiveness. If the treatment system is not performing as designed, then the system will be re-evaluated and re-designed, as necessary. It is beyond the scope of the IM/IRA to specifically identify penalties related to the enforceability of the performance of the proposed accelerated action. The IM/IRA identified the NPDES outfall as SW00196, the monitoring location after treatment. Due to the change in the treatment location, the NPDES outfall will be moved to where the water is discharged from the treatment tank. This point is not considered a RFCA surface water point of compliance (POC). RFCA surface water POC's are identified in RFCA Attachment 5. Surface water monitoring for No Name Gulch is conducted at the existing Indiana Street surface water point of compliance. Appendix A states that eight (four upgradient and four downgradient) RCRA

		groundwater monitoring wells have been established for the Present Landfill pursuant to RFCA and RCRA. Section 6.3 states that the existing downgradient RCRA groundwater monitoring wells will be groundwater POC wells for RFCA Attachment 10. Section 5.1 states "a monitoring and maintenance manual will be prepared after cover construction and will incorporate the regulatory requirements for inspection and maintenance of the cover and for groundwater monitoring."
)	3. If there is an exceedance, impacted local governments need to be notified and they need to be part of the consultative process to determine further actions. If there is an exceedance, water discharge needs to be discontinued and the water shall meet water quality standards before it is discharged to waters of the state.	The seep treatment system is part of the accelerated action and the treatment tank effluent is regulated under the IM/IRA. Appendix A identifies the monitoring reporting requirements for the treatment system. If the treatment system is not performing as designed, then the system will be re-evaluated and could possibly be enhanced or re-designed, as necessary. Since this is a CERCLA action, formal public review and comment periods for proposed actions may be required, however, the community will have an opportunity to participate as a part of the consultative process. Seep water will be sampled after treatment and prior to discharge to the East Landfill Pond. If an elevated level is detected, the East Landfill Pond water will be sampled. If the East Landfill Pond water sample contains levels above the action levels in RFCA Attachment 5, Table 1, then the RFCA parties will evaluate if the East Landfill Pond water can be released, treated or managed in some other way. East Landfill Pond water will not be sampled prior to its release unless there is a seep treatment system sample result above effluent limits.
1	4. Westminster strongly disagrees with releasing the pond water into No Name Gulch. As neighbor to a community that is downstream from the existing drainage, we oppose releasing any waters into Walnut Creek that will not be sampled to determine the impact to water quality entering their community. We have worked diligently with the Site to determine cleanup levels in the soils and surface water technical memorandums to ensure protection of surface water quality. To ensure long-term protection and monitoring of surface water post-closure, Westminster intends to see the water diverted to the A or B-series ponds prior to release into natural drainages. The rational is to provide an additional layering tool to measure the quality of surface water prior to its' release off-site. Water quality will additionally be measured at the outfalls of the A or B- series ponds and at	Seep water will be sampled after treatment and prior to discharge to the East Landfill Pond. If an elevated level is detected, the East Landfill Pond water will be sampled. If the East Landfill Pond water sample contains levels above the surface water action levels and standards in RFCA Attachment 5, Table 1, then the water will not be released. The RFCA parties will evaluate if the East Landfill Pond water can be released, transferred to the A-series ponds, or treated. East Landfill Pond water will not be sampled prior to its release unless there is a seep treatment system sample result above effluent limits. In addition, the sediments will be removed from the East Landfill Pond and the placed under the RCRA-compliant cover at the Present Landfill.

	the point-of-compliance (POC) at the site boundary at Indiana. In the event surface water being released into No Name Gulch does not reach Walnut Creek per the proposal, groundwater quality may be impacted from infiltration of the surface water.	
	Table 7, page 77 See my attached inspection checklist that is more comprehensive and would be a better beginning for an inspection checklist than what is in Table 7 at present.	Table 7 (now Table 1 in Appendix A) is a summary table of planned post-action monitoring and maintenance including weed control and is not a detailed checklist. We appreciate having your suggested checklist for consideration. Details of maintenance and inspection will be included in the Maintenance and Monitoring Plan.
;	Section 10, page 80 Add the following to the outline for the Closure report: RCRA closure certification signed by an independent, registered, professional engineer; and, a copy of the Monitoring and Maintenance Plan.	A section concerning closure certification has been added to the IM/IRA; however, only the closure certification report is required to be reviewed by a licensed professional engineer. The Monitoring and Maintenance Plan does not require a licensed professional engineer certification.
4	Appendix E Why where the following ARARs dropped from this IM/IRA as compared to the draft of August 6, 2002?	See responses below.
5	FISH AND WILDLIFE COORDINATION ACT, 16 USC 661 *et seq.* Purpose 16 USC 661 Impounding, Diverting, or Controlling of Waters 16 USC 662 Impoundment or Diversion of Waters 16 USC 663 Administration; Rules and Regulations 16 USC 664 Effects of Sewage and Industrial Waters 16 USC 665 Authorization of Appropriations 16 USC 666 Penalties 16 USC 666(a) Definitions 16 USC 666 (b)	These potential ARARs were incorrectly identified in the August 6, 2002 draft IM/IRA. The RFCA parties have determined that these requirements are administrative and not substantive in nature.
6	NATIONAL HISTORIC PRESERVATION ACT (NHPA), 16 USC 470 *et seq.* Identifying Historic Properties 36 CFR 800.4 Assessing Effects of the Activity on the Property 36 CFR 800.5 Documentation Requirements 36 CFR 800.8 Criteria of Effect and Adverse Effect 36 CFR 800.9 Protecting National Historic Landmarks 36 CFR 800.10 Historic Properties Discovered During Implementation 36 CFR 800.11 Emergency Undertakings 36 C800.12	These potential ARARs were incorrectly identified in the August 6, 2002 draft IM/IRA. There are no archaeological resources or American antiquities in the area of the proposed action requiring these requirements to be ARARs. RFETS has fully implemented an NHPA Memorandum of Understanding with the Colorado Historic Preservation Officer to address all historic preservation requirements related to site cleanup and closure.

	Preservation of American Antiquities 43 CFR 3 Protection of Archaeological Resources 43 CFR 7	
7	NATIONAL DEFENSE AUTHORIZATION ACT FOR FY2002 (Pub.L. 107-107, December 28, 2001) Rocky Flats Wildlife Refuge Act Subtitle F, Sections 3171 – 3182	**These potential ARARs were incorrectly identified in the August 6, 2002 draft IM/IRA. The refuge act does not meet the CERCLA definition of ARARs as "environmental laws" because it does not regulate any hazardous substance.**
8	COLORADO LAND RECLAMATION ACT FOR THE EXTRACTION OF CONSTRUCTION MATERIALS (CRS 34-32.5-101 *et seq.)* Duties of Operators – Reclamation Plan CRS 34-32.5-116(4)	**This was inadvertently left off the September 2003 draft IM/IRA and will be added to Appendix E.**
9	In addition to these comments, the City requests that Dr. Steve Dwyer of the Sandia National Laboratories and/or an independent environmental consulting/design firm acceptable to the City, review the design of the final cover.	**An independent review is not needed for the RFCA parties to fulfill each agency's respective regulatory review, oversight function and responsibility.**

Environmental Protection Agency Comments
Draft Interim Measure/Interim Remedial Action (IM/IRA)
for Operable Unit 7 (IHSS 114) and RCRA Closure of the RFETS Present Landfill

Comment No. (ref)	Comment	Response
	GENERAL COMMENTS	
	Administrative Requirements for Closure Document	
1	The document does not present an adequate level of detail and information to allow for independent evaluation and cannot be considered acceptable as a Closure Document. This document should serve as a stand-alone document for inclusion in the Administrative Record. In particular, Sections 2.0, 2.6, and 4.0, do not provide the reviewer a clear understanding of the landfill source, the current condition of the landfill to be able to properly evaluate the proposed alternative, the setting that the landfill may have impacted, and the nature and extent of contamination. Instead, the document includes a citation to previous documents, which do provide more detail. The information presented in this document does not provide an adequate transition or update of the information from the previous drafts. It is agreed that in some cases it is appropriate to cite existing information, however, previous documents, such as the Final OU7 Work Plan Technical Memorandum (DOE 1994) and the OU7 Revised Draft IM/IRA Decision Document and Closure Plan (March 1996), presented key information it appears that has not been used to support closure at the site. It is recommended that previous information as presented in the historical documents, as cited above, be reviewed and used as a guideline for providing a document that can be considered acceptable for Closure purposes.	The proposed action is to close the Present Landfill with a RCRA Subtitle C compliant cover. This closure implements the CERCLA presumptive remedy for the Present Landfill (the source of contamination) as source containment, and complies with the substantive requirements for closure RCRA Subtitle C. Under the CERCLA presumptive remedy guidance, operational history, process knowledge and existing characterization data are usually sufficient to determine whether the source containment remedy is appropriate. This information is extensive for the Present Landfill and the level of detail necessary for the source containment remedy is provided in this IM/IRA, specifically in sections 2.3-2.6. Additional characterization of a landfill's contents is not necessary or cost-effective; rather, existing data are used to determine whether the containment presumption is appropriate (per OSWER Directive 9355.0-49FS). In addition, a detailed description of the nature and extent of contamination is not warranted. A comparison of the existing data to RFCA Action Levels is provided in the IM/IRA to determine if an accelerated action, beyond containment would be required.
	Ecological and Geohydrological Setting	
2	The document indicates that there are key ecological and geohydrological data that are either missing, not reported, and/or are not understood. The lack of representation of this information in the report leaves the impression that the available information is too incomplete to form the basis of an informed assessment of remedial action alternatives. Specific items include, but are not limited to, unexplained contamination downstream of the East Landfill pond, and data gaps in the description of the ecosystem. Specific items are discussed in the following sections and in the specific comments.	Potential groundwater impacts from the East Landfill pond are discussed in Section 2.6.3. This section concludes that the elevated concentration of contaminants is likely not associated with the Present Landfill, based on a water quality assessment (provided in Appendix C), supported by the hydrologic flow model and analytical data from the Present Landfill seep. As stated in the IM/IRA and in Appendix C, the elevated concentration of metals and anions found downgradient from the pond may be attributed to natural processes involving evapotranspiration, and/or mineralization along the groundwater flow path. However, the IM/IRA does state that there is some potential that seepage or underflow of the dam is possible, which may also contribute to elevated

		concentrations observed in downgradient groundwater quality. Section 2.5.9 regarding the Ecological Setting has been revised to provide more detail regarding vegetation and wildlife in the area of the Present Landfill. However, nothing in this additional detail makes the known information and assumptions invalid. In addition, the IM/IRA has been revised to include the removal of the sediments from the East Landfill Pond and placement of these sediments under the RCRA-compliant cover of the Present Landfill.
	Ecological Setting	
3	The discussion of the ecological setting, as presented in Section 2.5.9, provides only a partial description of the ecosystem in the immediate vicinity of the landfill and does not provide enough detail to document the baseline environment in order to satisfy the evaluation of alternatives resulting from any of the proposed actions. The description should be expanded to include a more specific description of the habitat and include diversity of plant populations, populations of mammals, and waterfowl and other avian species, that use the landfill and the surrounding ecosystems. The ponds, wetlands, and associated intermittent drainages should also be described in detail. A figure which delineates the landfill, No Name Gulch, and all surrounding habitat types should be included in the report.	Section 2.5.9 regarding the Ecological Setting has been revised to provide more detail regarding vegetation and wildlife in the area of the Present Landfill.
	Evaluation of Impacts to Ecological Receptors.	
4	The manner in which the discussion and comparisons to RFCA Action Levels and Water Quality Standards are made should be clarified throughout the document. For example, the document suggests that there are few or no exceedances to the RFCA Action Levels or 'Surface Water Standards,' however, it appears that the benchmarks are associated to an evaluation of human health, and ecological impacts have not been evaluated. For example, Table 3 indicates that there only three ecological Action Levels, however, the text suggests that there are no ecological action level exceedances and does not address or identify that the evaluation of ecological receptors is incomplete since only three ecological Action Levels were used.	The surface water action levels and standards are based upon Colorado Water Quality Control standards for Walnut Creek segments 4a and 4b, which include standards for protection of aquatic life when more conservative than the human health based standard. Although ground water action levels are based on protection of human health, evaluation of risks posed by contaminants in ground water includes protection of surface water quality. The RFCA Parties have not yet agreed to ecological receptor soil action levels (which also apply to sediment) for all analytes in Table 3, but work is continuing in this regard. The IM/IRA Table 3 does not list the ecological receptor soil action levels, but these action levels are established in RFCA Attachment 5, Table 3, Soil Action Levels for some key analytes listed in IM/IRA Table 3. The analytes are arsenic, beryllium, lead, vanadium, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoanthene, benzo(k)fluoanthene, 2-butanone and toluene. Except where the ecological receptor soil action level is set at the analyte's background concentration (e.g., lead), the measured concentrations are well below the action levels. (See also

		IM/IRA Attachment D for comparison of analytes found in soil samples to the existing ecological receptor soil action levels). Also, several analytes with existing ecological receptor action levels were not detected above background in sediment or soil. DOE has determined that the source containment accelerated action will be protective of ecological receptors in the long term. In addition, the IM/IRA has been revised to include the removal of the sediments from the East Landfill Pond and placement of these sediments under the RCRA-compliant cover of the Present Landfill.
	Aquatic Resources	
5	Details regarding surface water flow as it relates to groundwater seeps and discharges have been presented in other sections, however, the description of the surface water and aquatic resources associated with the landfill does not provide enough detail to document the aquatic ecosystems at the site. For example, it is stated that the intermittent nature of North and South Walnut Creek "do not support sizable amounts of aquatic species". However, no other description of North and South Walnut Creek has been provided and a conceptual site model for evaluating ecological exposure and risks at the site has not been provided. In addition, there is no discussion of the terminal or receiving water bodies for ultimate discharges of the creeks to offsite resources. The baseline aquatic habitats and existing condition of No Name Gulch, North and South Walnut Creek, and the East Landfill Pond should be clearly established for evaluating ecological risk at the site. The aquatic and semi-aquatic (i.e., amphibians and waterfowl) populations associated with the water bodies should be described to meet this objective. Revise the document to include a conceptual site model and provide additional details regarding the open water habitat and aquatic ecosystem associated with the East Landfill Pond. The section should be expanded to include a figure to delineate the seeps, ponds, wetlands, drainages, and creeks in the context of the habitat.	Additional information on the aquatic habitat found at the East Landfill Pond has been added to the Ecology description in section 2.5.9, as well as a description of No Name Gulch. North and South Walnut Creek are not connected to No Name Gulch except beyond the point at which they have previously joined to form Walnut Creek. Therefore, since there is no direct connection to No Name Gulch, discussions in the Present Landfill IM/IRA on North and South Walnut Creek are not warranted. Ecological risk will be evaluated in the Accelerated Ecological Screening process and in the Comprehensive Risk Assessment.
	Geohydrological Setting.	
6	The document indicates that there are constituents in the groundwater down-gradient of the landfill which are not found in wells upgradient of the landfill. There is no technically sound explanation for this occurrence. This leaves the impression that leachate from the landfill is bypassing the East landfill treatment system and pond and impacting the groundwater down stream of the pond. The last paragraph on page 15 states "... the groundwater intercept system was also designed to discharge into the pond; however, data are unavailable to indicate whether this occurs." If it is unknown whether the intercept system discharges into the pond, then its effectiveness is unknown.	As described in the modeling report, although the calibrated model assumed that the external GWIS drain was operational, a sensitivity analysis was performed to evaluate how the system responded without an operational GWIS drain. Results showed that heads increased slightly external to the landfill GWIS, but in general, simulated heads reproduced observed heads reasonably well without the external drain operating. In addition, the seep discharge also increased as a result of the increased gradient in towards the internal GWIS landfill drain which preferentially drains to the former western pond area and then to the seep. Either way, simulated heads, flow paths and seep discharge rates were similar for both cases. Therefore,

	Therefore, modeling involving the intercept system cannot be verified and model results cannot be compared with field measurements. This undermines the validity of the modeling effort. Please provide justification and rationale for placement and locations for the ground water monitoring wells pursuant to 40 CFR 265 Subpart F. Further evaluation of water quantity and quality is needed to provide a basis for defining the existing and potential groundwater problems and analyzing remedial action alternatives.	the model results were generally not sensitive to whether this external drain is operational or not. Ultimately, it is likely that the external GWIS drain simply drains groundwater from areas of higher heads to areas along the GWIS where levels are lower, but never discharges into the non-perforated portion of the pipe. The existing monitoring wells are located directly downgradient from the landfill, and as close as practical to the unit. Groundwater flow paths within and surrounding the landfill indicate that groundwater originating from the landfill cannot bypass these downgradient wells. Additionally, the groundwater immediately downgradient of the East Landfill Pond will be evaluated in the RFETS Groundwater IM/IRA.
	Landfill	
	Source Characterization	
7	The document tries to give the impression that the landfill does not contain a substantial mass of hazardous materials but contains materials equivalent to a municipal landfill. Consequently, emphasis on a secure cover is not provided in the document. The facts (as presented in previous documents) are that the landfill contains substantive quantities of hazardous constituents, has no liner or leachate collection/leak detection system consistent with any RCRA subtitle, is susceptible to the rise and fall of the surrounding groundwater regime and precipitation, and is very vulnerable to natural forces of degradation. An effective permanent cover is the primary component in the landfill remediation system, which under fully protective circumstances would have a double- of triple- composite liner, leachate and leakage collection and treatment systems, in addition to the components included in this document. Therefore a RCRA subtitle cover with all the applicable options is a requirement for the long-term protectiveness of human health and the environment.	Based on operational history and the waste management programs and controls in place during operation, the vast majority of wastes in the Present Landfill were not hazardous wastes and do not contain hazardous constituents. DOE believes that based on this information and the low levels of the types and quantities of wastes disposed in the Present Landfill are very consistent with wastes disposed in typical municipal sanitary waste landfills operated during the same period. However, the proposed action is to close the Present Landfill as a RCRA interim status unit because it is believed that small volumes of some hazardous wastes were disposed after the effective date of RCRA. This closure will include a RCRA Subtitle C compliant cover to meet CERCLA ARARs.
8	The source characterization information presented in Section 2.4 does not present an adequate characterization of waste or a description of the historical contamination likely to be present in the landfill. The current description appears to suggest that there are no hazardous wastes in the landfill and has omitted any discussion of the deposition of metals and PCBs (as indicated in Section 2.1 of this report). For example, the document suggests that the Waste Stream Residue Identification and Characterization (WSRIC) program conducted in 1989 documented that the 183 previously identified waste streams are considered non-hazardous. However, it is not clear what media were measured or how the measurement of the waste streams relates to the RFCA Action Levels. It is recommended that the document clarify how	Under the CERCLA presumptive remedy guidance, operational history, process knowledge and existing characterization data are usually sufficient to determine whether the source containment remedy is appropriate. This information is extensive for the Present Landfill and the level of detail necessary for the source containment remedy is provided in this IM/IRA, specifically in sections 2.3-2.6. Additional characterization of a landfill's contents is not necessary or cost-effective; rather, existing data are used to determine whether the containment presumption is appropriate (per OSWER Directive 9355.0-49FS). Section 2.4 Source Characterization does indicate that waste containing hazardous constituents was placed in the landfill. The document also states that a total of

	wastes were characterized for the WSRIC program and how the definition of hazardous waste streams in the WSRIC program relates to the current RFCA Action Levels.	241 non-hazardous solid waste streams and 97 potentially hazardous waste streams were disposed of in the Present Landfill prior to the fall of 1986, when procedures were put into place to cease and prevent the disposal of hazardous waste into the landfill. In 1989, waste streams were further characterized under the WSRIC program in which 183 waste streams were identified to have been disposed of in the landfill between 1986 and 1998, none were determined to be hazardous. This does not state that previously identified waste streams are non-hazardous. The WSRIC process evaluated processes and waste generated on-site that was destined for disposal at the Present Landfill. Using knowledge of the process that generated the waste, a conservative approach was developed to ensure that any potential hazardous waste would no longer be sent to the Present Landfill. No sampling of media was conducted under the WSRIC program.
	Nature and Extent of Contamination	
9	The discussion of the nature and extent of contamination assessment presented in Section 2.6 does not provide a clear explanation of the methodology that is used to identify 'contamination' (e.g, comparison to background/RFCA Action Levels), or indicate the chemicals of potential concern associated with the unit. For example, Table 4 presents a comparison of mean sediment concentrations to the wildlife refuge worker soil action levels. The relevance of comparing sediment from within the pond to soil action levels associated with a wildlife refuge worker is not understood and does not explain the nature and extent of contamination associated with the landfill leachate discharges into the pond. The first paragraph of Section 2.6 indicates that information taken from the OU7 Final Work Plan Technical Memorandum (DOE, 1994) and other documents is summarized, but is not reiterated. The summary does not adequately capture the information presented by the documents cited and does not provide a clear documentation of the nature and extent of contamination based on all available and current data as presented in the reports cited. The closure document should present a clear and concise description of the nature and extent of contamination in order that appropriate documentation of the conditions at the time of closure exists in the Administrative Record. The nature and extent of contamination as presented in OU7 Final Work Plan Technical Memorandum provided a much clearer understanding of the contamination in each media based on data collected as of 1994. The format and information as presented in that work plan should be reiterated, and then updated and augmented with all new data from the Site IMP (DOE 2000), Annual Groundwater Monitoring Reports, and the Water Quality Assessment for the Present Landfill (Appendix C).	We believe "Table 4" refers to Table 3. Because RFCA implements an accelerated action approach, an evaluation of soil and water contamination concentrations that exceed the relevant action levels and standards in RFCA Attachment 5 is required. DOE believes that the summary, given that the source of information is clearly identified and is a part of the Administrative Record File for this action, is adequate to explain the basis of the proposed action. The proposed action is the presumptive remedy of containment. As such, a more detailed description of the nature and extent of contamination is not needed. RFCA provides that this information may be contained in a "brief summary" in an IM/IRA and this is also consistent with CERCLA guidance. Instead a comparison of contamination concentration to RFCA action levels is provided in order to evaluate and determine if any additional accelerated action is required. The title of this section will be changed to RFCA Action Level Comparison.

	Methodology for Comparison to Background and Identification of Chemicals of Potential Concern.	
10	Comparisons to various RFCA action levels and background levels are made throughout the document without any explanation as to their relevance. Please add a subsection to describe all the different criteria being used, provide a discussion of all background data for all media, and present a summary table showing all of the actual values being used for comparison. The information could be presented in the revised nature and extent of contamination section and include an updated discussion similar to Section 4.1, Methodology for Background Comparison and Identification of Chemicals of Potential Concern (COPC), as presented in the OU7 Final Work Plan Technical Memorandum.	See response to comment 9. A background comparison was also conducted for each media as discussed in section 2.6. Soils were evaluated against background defined as background mean plus two standard deviations for metals and the method detection limit for SVOCs. The background mean plus two standard deviations was calculated based on background mean data presented in the *Background Geochemical Characterization Report,* September 30, 1993. While not specifically referenced in Section 13, it is listed as a Reference in other documents cited in Section 13. This document will be added to the Reference List and is available in the Administrative Record File. For groundwater, seep water, sediments and pond water background comparisons were made using inferential statistics as provided in previous reports using the same data as reported in the 1993 *Background Geochemical Characterization Report.* Inferential statistics is an analysis of the variance testing of whether the means are the same between the specific Present Landfill data and the background data as presented in the 1993 *Background Geochemical Characterization Report.* The previous reports were written prior to the time that it was decided to use background mean plus two standard deviations at the "background" number for the site in lieu of conducting inferential statistics each time a comparison to background was required, and before the RCFA action levels were established.
	Cover Design	
11	The design of the cover does not include sufficient detail to be properly evaluated. Features and minimum thickness of each layer must be described. Each cover component, its function, design criteria, and how the design meets the design requirements must be presented in the document. Considerations include, but are not limited to, erosion protection, infiltration, runoff protection, frost protection of the GCL layer, biota barrier, vegetation, and longevity of all cover components.	This IM/IRA does serve as the Closure Document for the Present Landfill and provides a conceptual description of the proposed action (see Section 4), meeting the requirements for closure under 40 CFR 265 (see Section 6). The design of the accelerated action will provide detailed design drawings, specifications and quality control procedures for the construction of the cover. However, the proposed cover configuration has been modified above the geosynthetic liner to provide a vegetative cover (See attached cover cross-section).
	Evaluation of Proposed Alternative	
12	The report includes several statements that indicate the selected alternative meets the Remedial Action Objectives (RAOs). While it can be agreed that the RCRA subtitle C cover will meet the formal list of RAOs, the placement of a cobble cover does not coincide with the informal objectives for establishing a	The RAO's take into consideration the reasonably anticipated future land use, in accordance with CERCLA policy and guidance. This closure approach is not inconsistent with the anticipated final remedy for the site. Achieving a condition that may optimize the aesthetics or promote a specific management approach for

	condition compatible with the future use as a National Wildlife Refuge. In previous meetings with DOE and its contractors, it was indicated that cobble is more expensive than soil. However, the specific variables that would be associated with a cost comparison between the two alternatives have not been presented. It is recommended that this alternative, more conducive and suitable for the future use as a Wildlife Refuge, be seriously considered. The use of the cobble cover alternative in lieu of a soil and vegetated cover should be more specifically evaluated to document the differences in cost and consider increased health hazards associated with increased heavy truck traffic for transporting the large volume of cobble on public highways. The specific soil type and volume requirements for a vegetated cover should be evaluated to determine whether there are on-site borrow areas for portions of the soil volume requirement which would make a vegetated landfill cover more feasible.	the anticipated future refuge is not required in taking response actions under CERCLA. However. DOE will continue to consult with the community and with the Fish and Wildlife Service to assist in and support achieving the refuge goals.
	Ground Water Monitoring	
13	The effects of the new cover including changes in surface water and ground water flow may occur which could impact surface water and seep water quality. This must be monitored. Point of compliance wells for surface water and ground water must be used and be in locations to adequately monitor changes from the landfill. Ground water monitoring must be conducted until conditions are defined in such a way that the parties agree that further monitoring is not necessary.	The IM/IRA states that eight (four upgradient and four downgradient) RCRA groundwater monitoring wells have been established for the Present Landfill pursuant to RFCA and RCRA. This section describes what is being monitored for and for how long. The RFCA Parties can consult, as necessary, to change the monitoring regime. The IM/IRA also states that the existing downgradient RCRA groundwater monitoring wells will be groundwater POC wells for RFCA Attachment 10. Additionally, the IM/IRA states that surface water monitoring for No Name Gulch is conducted at the existing Indiana Street surface water point of compliance. The IM/IRA describes the monitoring requirements for the seep. The NPDES outfall for the seep will be the discharge point from the treatment tank.
	Post-Closure Plan	
14	A more comprehensive and detailed post-closure plan must be included with details specifying institutional controls to be utilized. We do not concur with deferring post-closure care to the Corrective Action Decision/Record of Decision.	The IM/IRA identifies the post-accelerated action requirements. The IM/IRA was drafted as comprehensively and detailed as possible for this point in the process. It is not possible to know all of the post-closure care requirements until the final cover is installed and the accelerated action monitoring and inspection is started. While final requirements could be specified in the close out report, that document is not subject to formal public review and comment prior to approval. The final CAD/ROD will document the final post-accelerated action requirements and the public will have an opportunity to review and comment on those requirements in the RI/FS and Proposed Plan.
	Seep Management	

15	Several items related to seep management are unclear. These include, but are not limited to, how terms and standards are defined and used, and how the point of compliance is defined and applied.	Definitions of East Landfill Pond, No Name Gulch drainage, Present Landfill leachate and Present Landfill seep are provided in Section 1.0. The point of compliance (POC) for No Name Gulch drainage is at Walnut Creek and Indiana Street.
	Terms	
16	The terms groundwater, surface water and seep should used consistently throughout the document. These terms should be defined and the limitations of these terms must be discussed in this document.	The document has been reviewed and revised in order to provide a consistent use of the terms surface water, groundwater and seep. The Present Landfill seep is defined in Section 1.0. Definitions of groundwater and surface water were not provided in this document since currently available terms exist within the environmental field as well and regulatorily.
	Surface Water Standards	
17	In general, the use of mean concentrations to 'Surface Water Standards', as presented in Table 4, should be clarified. The data used to generate the mean concentration and the use of the mean for comparison has not been discussed and must be included. In addition, the table presents both total and dissolved results for metals, but does not discuss how either of these results should be considered. The table also presents a column labeled 'SW Standard', however, it is not clear whether the standard is related to human health or aquatic life exposures. It is also not clear why the standards presented in Table 4 of this document are not always consistent with those reported in RFCA, Attachment 5, Table 1, or why only a subset of the analytes included in RFCA have been presented for this evaluation. For example, historical deposition of chromium contaminated materials in the landfill has been indicated, however, chromium is not included in the surface water analyte list presented on Table 4. The rationale for the manner in which the evaluation has been conducted should be clarified. The document should be revised to include all ecologically-based WQS for all chemicals. The document should also clearly identify whenever data are lacking and indicate that an evaluation of ecological impacts has not been completed for these chemicals.	Table 4 was taken directly from the OU 7 Final Work Plan Technical Memorandum (see the ref. to DOE 1994). Details of the sample coverage, comparisons to background, and calculation of the mean are presented therein. The analytes shown, as stated in the text and indicated in the table footnote, are those that were at concentrations exceeding background levels. Chromium was not above background. The analysis of the data is qualitative, i.e., the maximums and the means have been compared to the RFCA Attachment 5, Table 1 "Surface Water Action Levels and Standards" to characterize the quality of the water relative to the action levels, looking at worst case (maximums) and average (means) conditions. The comparison was conducted to evaluate whether the water quality was at or below the actions levels, with the objective of determining if the pond water should be addressed in the landfill closure design. Whether the action levels are based on human health or ecological considerations is not relevant to the objective. The standards shown in the table are from the above referenced Table 1; however, a typo was discovered in review of the values (the barium standard is 0.49 mg/l, not 0.46 mg/l as shown). The original presentation of both total and dissolved concentrations was to examine if the constituents were in the particulate or dissolved phase. From a compliance perspective (and this was not a formal compliance assessment), total concentrations, total recoverable concentrations (this data was not collected), and dissolved concentrations should be compared to the appropriately based actions level. The text provides discussion of the data relative to total and dissolved concentrations.
	Landfill Pond	
18	This document does not address the impacts and future of the landfill pond and associated wetlands issues with respect to the steepness of the east slope of the landfill. The Proposed Action should indicate that Monitoring and	The pond will not be modified as a result of information gained during the design activities. The east side of the landfill will be addressed as a part of the proposed action design. The IM/IRA has been revised to include the removal of the

	Maintenance associated with the pond will be forthcoming. These details should be discussed in the document.	sediments from the East Landfill Pond and placement of these sediments under the RCRA-compliant cover of the Present Landfill.
	Surface Water Monitoring	
19	As long as there is a discharge to waters of the US/State, under the CWA, monitoring and reporting must be conducted, regardless of whether there is an exceedance of water quality standards. Under the CWA, a discharge without a permit is a violation of the Act. This discharge must be covered in perpetuity by an NPDES permit or equivalent under CERCLA in order to comply with the requirements of the CWA, not just for two years.	The IM/IRA describes the monitoring requirements for the seep. The text states that during the CERCLA periodic review, the RFCA parties will evaluate whether continued monitoring is required after a proposed sampling period. The time frame itself does not mean that sampling could discontinue automatically. The evaluation will include a thorough data analysis. The appropriate regulatory requirements will be followed if there is a discharge to waters of the State/US.
	SPECIFIC COMMENTS	
20	Section 1.0, Page 2. The third paragraph indicates that several IHSSs and PACs located near the Present Landfill have been approved by EPA for 'NFA'. It should be noted that these actions were considered No Further Accelerated Action, or NFAA, and should not be considered final until the completion of the in-progress Comprehensive Risk Assessment. Please correct the terminology to reflect that EPA has given approval for a NFAA rather than an NFA.	See Footnote 3 at the bottom of page two, which indicates that the term NFA is used in this document consistent with the terminology used at the time of the NFA determination. DOE acknowledges that the current term used is No Further Accelerated Action (NFAA).
21	Sections 2.5.5 and 2.5.6, Pages 15 through 17. These sections discuss the hydrologic and hydrogeologic setting of the Present Landfill. The discussion is confusing and portions are apparently unsubstantiated. The last sentence on page 15 indicates that there is no information to confirm whether the groundwater intercept system is functioning as designed to discharge into the East Landfill pond. Also, the last paragraph on page 16 states that the "...East Landfill Pond water likely percolates downward into the underlying bedrock materials and laterally through the dam...then flows within shallow alluvium within No Name Gulch drainage, where it flows until it is discharged as evapotranspiration or as surface flow in No Name Gulch drainage." These vague statements provide an unclear explanation of key components of the hydrogeologic setting and water quality impacts of the possible groundwater flow scenarios. For example, the chemical characteristics and fate of the constituents in the seepage that bypasses the East Landfill pond dam are not discussed. Also the fate of these constituents that remain in the drainage when this seepage water is lost due to evapotranspiration is not discussed. The first paragraph on page 17 states..." throughout the Present Landfill area	Key hydrologic components are identified and briefly described in Section 2.5.5. They are described in terms of inflow, outflow and general flow paths. The modeling, discussed later in Appendix B, was conducted to quantify and support the general conceptual flow paths. The scope of the integrated flow modeling conducted in this study did not consider the fate and transport. The statement about the GWIS system discharging to the East Landfill pond is not incorrect. However, the GWIS drain was also designed to drain east of the pond dam. No information was available on the quantity or location of discharge associated with this drain. Current data is insufficient to accurately determine the fate and transport of seep water from the landfill, beneath the pond and then through, or under the dam. However, the data is sufficient to indicate that the landfill is not significantly contributing to groundwater or surface water contamination even with the existing soil cover. The proposed cover is not anticipated to negatively impact the groundwater. In addition, groundwater immediately downgradient of the East Landfill Pond will be evaluated in the RFETS Groundwater IM/IRA. Vertical gradients throughout the landfill model area are both upward and

	hydraulic gradients generally indicate a net downward component of flow….in near-stream areas, or seep locations, gradients are upward……slightly upward gradients locally due to increased evapotranspiration effects in the shallow UHSU." Similarly, an unclear image of the facts results from these sections. These sections should provide both a clear discussion of the available data and an explanation of apparent inconsistencies. Unclear or unsubstantiated information should be identified and an explanation should indicate how these information gaps will be addressed and how the lack of clarity affects the meaningfulness of the discussion. Also, please include a three dimensional hydrogeological figure showing well locations, depths, and screened intervals, in the context of the landfill, seeps, and the subsurface conditions, such as the vadose zone and aquifers.	downward. The PAM discussion described where these gradients are up and where they are down. Because there are only a limited number of well pairs where vertical gradients can be assessed, model results were used to support general statements regarding the nature of vertical gradients throughout the model area. The first paragraph on page 17 indicates that vertical gradients within the landfill waste area, based on modeling results, are small, but generally downward. Model results, however, also indicated slight upward gradients within the waste material in localized areas that are attributed to near-surface unsaturated zone moisture deficits caused by evapotranspiration.
22	Section 2.5.7.3, Page 20. This section describes the key findings of the model study that was performed using the MIKE SHE computer code. The first bullet of this section indicates that model calibration focused on matching average 1994 groundwater levels, timing, and magnitude of system response at wells, and the seep flow at SW097. Because the model does not account for capillary terms, for sites like Rocky Flats in semi-arid areas, there is a concern about accuracy and appropriateness of the model for this specific site. Distortion of model results may lead to the conclusion that infiltration is playing a larger role, whereas groundwater flow is actually contributing more to the observed responses at SW097. The effect of ignoring capillary terms should be investigated and discussed so as to clarify that the results are not just an artifact of the model and are representative of site-specific conditions. If the basic MIKE SHE computer code was revised to account for site specific conditions, a discussion of specific revisions and a diskette with the modifications and all supporting information should be attached as an appendix to this document.	The MIKE SHE model does in fact include capillary terms in the unsaturated zone portion of the model. The Richard's equation, a standard one-dimensional flow equation used widely to simulate unsaturated zone flow includes both gravity and capillary terms. The equations are further described in the SWWB Modeling (KH, 2002). The applicability of the code was evaluated in a code verification study conducted jointly by DHI, the code developers, and Dr. Illangasekare and Dr. Prucha. A report was prepared showing it is applicable within a semi-arid enviornment (KH, 2001). No computer code revisions were made to account for site conditions.
23	Section 2.5.9, Page 22. The text indicates that there are no Threatened and Endangered (T&E) plant species have been found in the vicinity of the landfill. Please document whether US Fish and Wildlife (USFWS) or state wildlife personnel have been involved in documenting the presence/absence of T&E species and indicate whether other non-plant T&E species have also been surveyed in the area.	T & E plant surveys were conducted in 1992, 1993, and 1994 in all the drainages at RFETS. They looked specifically for the Ute Ladies-tresses Orchid and the Colorado Butterfly Weed plants. The USFWS survey methods for each of these species surveys were followed. Additionally, 10 years of wildlife surveys (bird surveys and relative abundance surveys) and several years of floristic surveys (high value vegetation surveys) in the vicinity of the landfill have never documented any T&E species at or near the Present Landfill. Small mammal

		trapping was conducted near and around the East Landfill Pond during late 1995 and in 1996. No T&E species (i.e. Preble's mice) were captured. RFETS has submitted annual reports to the USFWS which document trapping activities related to the Preble's mouse. The USFWS has reviewed the reports and the information was entered into a database.
24	Section 2.6, Page 23. It is stated that the information in this section is a summary from existing reports, but does not reiterate all the information. The IM/IRA report must include enough information to clearly document the nature and extent of contamination to support remedial decision making associated with each of the proposed actions. While it is appropriate to reference certain existing documents, the presentation does not provide an adequate description of the nature and extent of contamination used to support the alternatives analyses contained in this document. Revise the document to include locations of the seeps, soil, and sediment sample locations. Please revise the title of the section to Nature and Extent of Contamination Assessment.	See response to comment No. 9.
25	Section 2.6.1 and 2.6.2, Page 23. The last sentence in both of the subsections indicate that all potential contaminant concentrations are below RFCA Soil ALs as referenced in a DOE et al, 1996. The rationale for using the 1996 levels for this comparison has not been discussed. In addition, comparison of the detected concentrations to ecological ALs has not been conducted. Revise the text to discuss the relevance and availability of ecological action levels and expand the document to include an evaluation using ecological ALs. Alternatively, the document should be revised to indicate that the ecological risk assessment associated with the landfill has not been conducted as part of this effort and will be included in the Comprehensive Risk Assessment.	The reference is correct. Please see Section 13. RFCA is modified from time to time and the reference includes all modifications to date, including the 2003 modification to RFCA Attachment 5. The text also clearly states that the comparisons are to WRW ALs, which did not exist in 1996. Ecological risk will be evaluated in the Accelerated Ecological Screening process and in the Comprehensive Risk Assessment.
26	Section 2.6.3, Pages 23 and 24. The history of groundwater monitoring is not clear. For example, Page 22 indicates that a groundwater monitoring program began in 1986 and a formal groundwater evaluation was conducted in 1988, and includes a discussion of elevated levels of major anions and salts. The intent of the investigation is not evident by the discussion presented. It should be clarified whether a full suite analyses was conducted and only ions were detected or whether only ions were analyzed. The text should be revised to indicate the rationale for monitoring, which regulatory program that the groundwater monitoring was initiated (e.g., RCRA, NPDES), and the analyses required at that time.	A reference to Appendix Bwill be provided in this section, which provides the history of groundwater monitoring at the Present Landfill and includes the number of wells, the type of analytes sampled and the regulatory basis for conducting groundwater monitoring.

	The three seeps and sediment sample locations associated with the Present Landfill should be more clearly identified on Figure 2. Also, a contingency should be placed in the compliance monitoring plan which states that if exceedences occur in the major seep, additional sampling will occur in other seeps along the landfill.	Construction of the RCRA equivalent subtitle C cover over the Present Landfill area will include those areas where intermittent seeps have existed in the past. As a result, intermittent seeps will no longer be present at the Present Landfill.
27	Section 2.6.3.2, Page 25. It is stated that there were no concentrations of VOCs from any seep samples that were greater than Tier II groundwater action levels. Please clarify the rationale for the comparison to the Tier II groundwater action levels to surface water from the seeps.	There is no seep discussion in this section. This section is associated with VOCs in groundwater.
28	Section 2.6.4.2, Page 30. It is stated that concentrations were above surface water standards, but below site background concentrations. Please provide clarification as to which surface water standards are being used, and what background data are being used for this comparison.	All references to surface water standards in the IM/IRA are to the surface water action levels and standards listed in RFCA Attachment 5, Table 1. Background data are from the *Background Geochemical Characterization Report,* Golden, CO, September 1993.
29	Sections 2.6.5 and 2.6.6, Page 31. It is indicated that concentrations of inorganic analytes are above background levels based on inferential statistics. The location of the background surface water and sediment samples have not been described and it is not evident that use of statistics for this comparison is appropriate. Please clarify the rationale and data quality objectives for this analysis. In addition, the last sentence of Section 2.6.5 indicates that none of the analytes exceed the RFCA soil ALs as presented by DOE et al, 1996. The comparison of sediment concentrations to soil action levels is not appropriate. Please discuss potential for ecological exposures and revise the document to include sediment action levels. Alternatively, provide the rationale and justification for using soil action levels to evaluate sediment exposures.	The text references the OU 7 Final Work Plan Technical Memorandum, which provides the details of the background comparison. Comparison of sediment contaminant concentrations to WRW ALs is appropriate because the surface water regime in the future at RFETS is not completely known, and the sediments could become exposed and therefore is evaluated as soil in accordance with RFCA Attachment 5 with respect to the wildlife refuge worker's exposure to this medium. However, to address this concern, the sediments in the East Landfill Pond will be removed and placed under the RCRA-compliant cover of the Present landfill.
30	Section 4.1.1.2, Page 36 and 37. This section discusses the protectiveness of the ET cover alternative. The second paragraph assumes a construction schedule consisting of 4-10 hour days per week for 6 months. This represents an impractical worse-case scenario. It is not clear why other practical schedules, such as 7-6 hours days, from 11:00 pm to 5:00 am (similar to the TREX project) are not evaluated. The result is an artifact of the assumptions. Other practical assumptions should also be evaluated.	The evaluation of the cover alternatives considers the overall short-term and long term impacts of action and considers that the long term maintenance requirements of the proposed action are generally less than the short term negative impacts of the ET cover. Section 4.0 of the IM/IRA specifically discusses and calculates the additional safety risks associated with the construction of an ET cover. Clearly, the additional vehicle-miles required to build the ET cover and the associated accident rates is more than for the proposed geosynthetic cover alternative that uses more readily available materials located closer to the RFETS facility. It is our understanding that the TREX schedule was dictated by the need to close various portions of the highway to vehicles. Closure of the roadway was best done at night during periods of low traffic volume rather than time of peak traffic

		flow into and out of downtown Denver. The work schedule assumes that the truck loading (which is not under RFETS control) and unloading operation would occur during daylight hours, which is a reasonable assumption.
31	Section 4.1.2.2, Page 38. The second paragraph of this section indicates that the present landfill contains "limited amounts of hazardous wastes." Previous data indicated that the Present landfill contains approximately 30 percent hazardous wastes. A final accurate amount of hazardous waste in the landfill should be provided with supporting documentation.	The "previous data" source was not identified and still indicates that hazardous waste is a minority component. Under the CERCLA presumptive remedy guidance, operational history, process knowledge and existing characterization data are usually sufficient to determine whether the source containment remedy is appropriate. This information is extensive for the Present Landfill. Additional characterization of a landfill's contents is not necessary or cost-effective; rather, existing data are used to determine whether the containment presumption is appropriate (per OSWER Directive 9355.0-49FS). In addition, a RCRA Subtitle C equivalent cover will be placed over the landfill.
32	Section 4.1.3, Page 42. This section describes a proposed RCRA Subtitle C cover. The second paragraph indicates that components over the existing cover soil will include geosynthetic clay liner (GCL), flexible membrane liner (FML), geosynthetic drainage layer, a soil layer, and a layer of cobbles. The concerns about this proposal include but are not limited to those discussed below.	
	a. The EPA document indicating the proposed RCRA Subtitle C cover section should be cited. The reference EPA document for CERCLA /RCRA prescriptive covers (EPA 1991, Design and Construction of RCRA/CERCLA Final Covers, (EPA/625/4-91/0254) May 1991) indicates a Subtitle C cover that is significantly different from the proposed cover. b. The thickness of the soil and the cobble layers are not stated in this section. However, Table 5 indicates a 1-foot thick soil layer and Figure 4 indicates the soil cover is approximately 2-feet thick. c. The second paragraph refers to a biota barrier as a "deterrent to burrowing animals." EPA guidance documents for biota barriers indicate that to be effective as a biota barrier, the cobble layer should be at least 60 centimeters (24 inches) below ground surface. Cobbles placed on the surface do not serve as a biota barrier, and raise concerns about their longevity and resistance to the weathering effects	The proposed cover configuration has been modified above the geosynthetic liner to provide a vegetative cover (See attached cover cross-section) based on discussion among the RCFA parties.

	of climatic forces. Also material type and/or requirements, including durability and gradation, are not discussed. d. There is no discussion about protection of the GCL layer from freeze-thaw cycles. To provide a measure of assurance of long-term stability against freeze-thaw cycles, the GCL layer should be placed below the frost depth, or 3 to 3.5 feet below finished grade. Available information indicates that a cobble layer on the surface provide should not be credited with providing any protection against frost. In general, this section lacks detail and should provide additional information concerning the cover and requirements that the cover design must meet. As currently described, the cover does not appear to meet the prescribed requirements of a RCRA Subtitle C cover. In this document, for any proposed cover, supporting information must be provided to justify the selection of all the functional components of the proposed cover, including but not limited to the following: erosion protection, gas control, freeze-thaw protection of the GCL, biota barrier, infiltration elimination, vegetation support, stability of the east slope, and longevity of all materials used in the cover.	As presented in Section 5 of the IM/IRA, the geosynthetic liner materials will be placed below the frost depth calculated for the RFETS area. This IM/IRA does serve as the Closure Document for the Present Landfill and provides a conceptual description of the proposed action (see Section 4), meeting the requirements for closure under 40 CFR 265 (see Section 6). The design of the accelerated action will provide detailed design drawings, specifications and quality control procedures for the construction of the cover. EPA will review and approve the final design.
33	<u>Section 5.1, Page 53</u>. The first paragraph indicates that a layer of cobbles would be placed on the surface of the soil layer to prevent erosion. However, Section 4.1.3, page 42 indicates the layer of cobbles is intended to serve as a biota barrier. Although EPA guidance allows for cobble layers to serve as erosion protection and biota barrier, the two layers are not the same. The erosion protection layer is on the surface but the biota barrier layer is covered with at least 2 feet of soil. The document should be revised to clarify the differences between the function of the cobble layers. The section should be revised to indicate an erosion protection cobble layer on the surface and a separate biota barrier cobble layer at least 2 feet below the surface. However, frost protection may require 3 to 3.5 feet of soil above the biota barrier layer. Figure 4, page 55 should be revised accordingly. The second paragraph proposes to remove the four gas vents and states that they "may" be replaced by barometric vents as determined by an engineering design. Gas vents are a necessary component of this cover. Please revise the text accordingly to reflect this requirement.	See Response to previous question The existing vents will be removed. New vents will be designed and installed as a part of the proposed cover configuration. The vent's primary purpose will be to provide barometric venting required for covers with an FML; however, it will also vent any further methane production from the landfill.

34	Section 5.2, Present Landfill Seep, Page 54. This section indicates that the pond will be modified to include an outlet structure to allow water in the pond to flow into the existing drainage whenever the water level reaches a specific level. The plan should include the specific testing protocol to document that the water in the landfill is below water quality standards prior to the breeching of the pond and discharge to No Name Gulch. It is recognized that existing historical records which may be adequate to specifically identify the types of hazardous wastes and materials that may have deposited in the landfill are not available. Therefore, the pond sediments and surface water should be characterized for all possible waste parameters prior to opening the pond for flow through design. This is particularly critical because there are unexplained contaminants of concern down-gradient of the pond, as discussed in Appendix C. The second paragraph indicates that a Monitoring and Maintenance Manual will be prepared after cover construction….." This section should be revised to indicate that the Monitoring and Maintenance Manual will be developed concurrent with the design and submitted for approval prior to construction of the cover.	Sediments were sampled in the mid-1990's. Since the mid-1990's, VOCs were identified as the only constituents requiring treatment in the seep treatment system. VOCs are not expected to have impacted the East landfill Pond sediments and DOE believes that it is reasonable to retain the pond's existing outlet structure to allow water in the ponds to flow into the existing drainage when the water level reaches a specific level. The seep water will be sampled after treatment and prior to discharge to the East Landfill Pond. If an elevated level is detected, then the East Landfill Pond water could be sampled. If the East Landfill Pond water sample contains levels above the actions levels in RFCA Attachment 5, Table 1, then the RFCA Parties will evaluate if the East Landfill Pond water can be released or managed in some other way. East Landfill Pond water will not be sampled prior to its release unless there is a seep treatment system sample result above effluent limits. In addition, the DOE will remove the sediments from the East Landfill Pond and place the sediments under the cover of the Present landfill.
35	Section 6.2.2.3.1, Page 62 The fourth paragraph of this section indicates that special attention will be provided on the east-facing slope to monitor for any sloughing or movement of the side slope of the landfill. The approach to merely monitor this slope is not acceptable. The side slope must be designed and constructed with a specified maximum side slope to prevent erosion. This section should be revised to indicate that details will be provided consistent with the design specification and the Monitoring and Maintenance Manual.	The DOE is aware of the slope stability issues on the east-facing slope of the Present Landfill. The design of the cover will incorporate modifications to the existing grades of the landfill and the engineering will be based upon the appropriate slope stability calculations. The design of the accelerated action will provide detailed design drawings, specifications and quality control procedures for the construction of the cover. The EPA will review and approve the detailed design.
36	Section 6.2.2.3.2, Page 62. Groundwater monitoring must continue for a minimum of 5 years and until parties concur that no additional monitoring is necessary based on characterization of conditions and lack of contamination detected/present. Section 6.3 states that eighteen years of groundwater monitoring has been conducted, however, it is unclear which constituents were analyzed, and what frequency and which criteria were used to determine no contamination existed. This information should be provided. Regardless, due to changing conditions ground water monitoring should continue.	The post-accelerated action period for groundwater monitoring at the Present Landfill will be identified initially as 30 years, recognizing that the regulatory agency may shorten this period, if a reduced period is sufficient to protect human health and the environment. This evaluation will be conducted during the CERCLA five-year review period. Appendix B provides a history of groundwater monitoring at the Present Landfill, including the analytes monitored. Current groundwater monitoring follows the IMP for RCRA groundwater monitoring wells.

37	Section 6.3, Page 63 , indicates that low levels of volatile organic compounds are *slightly* above the RFCA Attachment 5, Table 1 Surface Water Action Levels and Maximum Concentration Limits for drinking water. The document should discuss comparison to ecological action levels. The paragraph also infers that reduction in infiltration afforded by the installation of the cover will subsequently prevent contamination that 'daylights' at the seep. Appendix C should be augmented to provide historical and current seep analyses compared to aquatic life water quality criteria in order to support the conclusion as stated.	The discussion of DCLs and ACLs centers on compliance with surface water action levels and standards regardless of their basis. If aquatic life water quality criteria are lower than human health criteria, then the aquatic life water quality criteria are the action level/standards. When this is not true, then compliance with the human health-based action level is protective of aquatic life. Appendix D does present all of the historical (SW097) and current (SW00196, SW00296, and SW00396) seep data, and provides an assessment of this data relative to the surface water action levels and standards. This comparison is how Table 1 of RFCA Attachment 5 was developed. See also section 2.2 of RFCA Attachment 5.
38	Sections 6.5.2.2 and 6.5.2.3, Page 65 and 66. These sections describe NPDES permit requirements applicable to the seep management system. Consistent with the stated NPDES requirements and protocols operating at other sites that have an "NPDES-like" permit, a more comprehensive suite of constituents must be developed for the long term monitoring program, including all metals and volatile organics (including benzene and vinyl chloride), the effluent constituents required per the hazardous waste landfill standards (40 CFR Part 445), as well as any applicable water quality standard for the receiving water (Walnut Creek standards). If certain constituents will not be monitored (such as the last two groups cited above), justification must be included in this document. A listing of all the constituents to be monitored must be provided. The frequency of monitoring proposed (one portion of the report says every six months, the other says yearly) is also not sufficient. Quarterly monitoring is required.	The RFCA parties determined, based on historical monitoring data associated with the Present Landfill seep, that good indicator parameters for changes in seep water quality are VOCs and metals. 40 CFR 445 is not applicable to the Present Landfill (Pursuant to 40 CFR 445.101 (e), it does not apply to discharges of landfill wastewater from landfills operated in conjunction with other industrial or commercial operations when the landfill only receives wastes generated by the industrial or commercial operation directly associated with the landfill). The NPDES permit writer has flexibility in determining the constituents to be monitored when landfill leachate contaminated ground water is being discharged. If in the future statistically significant changes to seep water quality are observed, an opportunity exists to add additional analytes to the sampling regime. The IM/IRA describes the monitoring requirements for the seep. The text states that during the CERCLA periodic review, the RFCA parties will evaluate whether continued monitoring is required after a proposed sampling period. The time frame itself does not mean that sampling could discontinue automatically. The evaluation will include a thorough data analysis.
39	Section 6.5.2.3, page 66 , indicates that the effluent limits are the surface water standards listed in RFCA Attachment 5, Table 1. Please specify that aquatic use water quality levels will be used as the limits for this evaluation. It is also stated that VOCs and metals will be monitored at SW00196 quarterly for two years. Surface water monitoring must be conducted in perpetuity. Historical information suggests that PCBs may have been disposed in the landfill. It is recommended that sediment samples from the settling basin, and from either beneath the seep or in the Landfill Pond, should be collected and analyzed in order to determine the suite of chemicals of potential concern associated with the Landfill Seep discharge. In addition, decomposition and degradation of	The effluent limits are the surface water standards applicable for the receiving water as listed in RFCA Attachment 5, Table 1, and include the basis for the level of the constituent in the 3rd column of the table. The IM/IRA describes the monitoring requirements for the seep. The text states that during the CERCLA periodic review, the RFCA Parties will evaluate whether continued monitoring is required after a proposed sampling period. The time frame itself does not mean that sampling could discontinue automatically. The evaluation will include a thorough data analysis.

	landfill wastes may result in changes in chemical composition or contaminant levels that are discharging from the landfill.	The constituents currently associated with the Present Landfill seep and identified in this decision document are benzene and vinyl chloride. RFCA parties agreed based on historical monitoring data for the seep that good indicator parameters for changes in the seep water quality are VOCs and metals. PCBs were historically sampled for in the seep in five separate events and never detected. If in the future statistically significant changes to the seep water quality are observed, the RFCA Parties will evaluate if the monitoring program or the seep treatment system should be changed. Historically the seep has been managed primarily as emerging groundwater, with very low levels of constituent contamination from infiltration from the landfilled waste, which flows into the pond. Other sources of water contribute to the landfill pond. Previous response actions employing active and passive treatment of the seep have been implemented for years to remove waste constituents prior to discharge to surface water. Because appropriate treatment levels were established in these actions, the water and sediments have had like impact from the landfill. Sediments were sampled in the mid 1990's. Since the mid-1990's, VOCs were identified as the only constituents requiring treatment in the seep treatment system. VOCs are not expected to have impacted the East Landfill Pond sediments.
40	<u>Section 6.6, Surface Water, Page 68 ,</u> states that the East Landfill Pond will be allowed to discharge through a flow through structure into No Name Gulch, which is connected to Walnut Creek. It is stated that surface water monitoring for Walnut Creek is conducted at the existing Indiana Street surface water point of compliance (POC). However, it is not evident how the existing Indiana Street POC for Walnut Creek is appropriate for monitoring possible discharges from No Name Gulch to Walnut Creek, since the two creeks converge at a point significantly upgradient to Indiana Street POC location. It is recommended that the POC for discharges to No Name Gulch and Walnut Creek be located at the seep into the East Landfill Pond, down stream of the East Landfill Pond, or at the point of discharge from No Name Gulch into Walnut Creek.	North and South Walnut Creek are not connected to No Name Gulch except beyond the point at which they have previously joined to form Walnut Creek. Therefore, since there is no direct connection to No Name Gulch, North and South Walnut Creek are irrelevant for a Present Landfill discussion. Based on historic samples, the Present Landfill has not impacted water quality at the East Landfill Pond and DOE believes that it is reasonable to retain the pond's existing outlet structure to allow water in the ponds to flow into the existing drainage when the water level reaches a specific level. The seep water will be sampled after treatment and prior to discharge to the East Landfill Pond. If an elevated level is detected, then the East Landfill Pond water could be sampled. If the East Landfill Pond water sample contains levels above the action levels in RFCA Attachment 5, Table 1, then the RFCA Parties will evaluate if the East Landfill Pond water can be released or managed I some other way. East Landfill Pond water will not be sampled prior to its release unless there is a seep treatment system sample result above effluent limits.

41	Section 6.6.2, Remediation Wastewater, Page 69, states that wastewater will be characterized and may be discharged in accordance with requirements of the Site's Incidental Waters Program. Please specify the analytical suites that will be utilized to characterize the wastewater prior to determining ultimate discharge requirements.	Remediation wastewater is not expected during the construction of the cover, since the existing waste within the landfill will not be disturbed. However, if wastewater were to be created, this wastewater would be managed like all other on-site wastewater through the RFETS Incidental Waters Program where water is sampled for radionuclides, organics and inorganics and results evaluated for appropriate management and disposition of the water.
42	Section 6.6, Page 55. This section implies that the point of compliance is at Indiana Street. This should be revised to indicate that the point of compliance is the point of discharge of the seep at the landfill boundary.	As stated in section 6.5.2.3, the NPDES outfall for the treatment system is at the point of discharge from the treatment tank. Surface water monitoring for Walnut Creek is conducted at the existing Indiana Street surface water POC.
43	Section 6.7, Wildlife (ARARs). There is no mention of the Threatened and Endangered Species Act. The section should indicate whether a survey has been conducted to document whether discharges to No Name Gulch would impact any protected species.	No Preble's mice or other T&E species have been documented in No Name Gulch. Trapping and telemetry work conducted in the main channels of Walnut Creek during 1999 did not document any movement of Preble's mice into No Name Gulch. Trapping conducted around the East Landfill Pond in 1995 and 1996 did not document Preble's mice in the vicinity of the pond.
44	Section 7.3, Page 73. It is indicated that long-term impacts to ecological resources will include physical alteration of terrestrial and aquatic habitats and residual chemical risks in areas adjacent to the landfill outside the cover. Previous sections of the document have not described the populations that may be using the area, or what chemical risks are occurring, and to which species outside of the cover. The baseline ecological setting, including potential exposures and risk, should be clearly presented in order to evaluate the proposed alternative. In addition, consistent information as to the proposed alternative should be presented in this section. If a layer of cobbles on the 30-acre landfill surface is to be proposed, then revise the section to discuss the long-term impacts to wildlife based on this alternative.	Additional information on the ecological resources, including wildlife likely to use the area, has been added to the ecology description section of the document. The proposed cover configuration has been modified above the geosynthetic liner to provide a vegetative cover (See attached cover cross-section) that is considered to be more consistent with the long-term use of RFETS as a wildlife refuge.
45	Section 8.1, Information Management, pages 17 and 20. Analytical results should be added to the bulleted list of information to be retained and stored.	Modifications to the text will be made as requested in this comment.
46	Appendix B. Appendix B discusses the integrated hydrologic model used to model the hydrology of the Present Landfill. A few concerns about the use of this model for this situation are identified below. a. The model does not account for capillary forces, which may be significant in a semi-arid environment.	a. The model does include capillary terms in the unsaturated zone module and has been shown to be applicable in a semi-arid environment. b. Calibration parameters were modified by adjusting them so that simulated heads and discharges were reasonably reproduced. Clearly, parameter values are only estimates and are uncertain to some extent. As such a sensitivity analysis was conducted partly to evaluate how much major modeling

	b. "Calibration parameters" were identified, but no details were provided on how they were modified. c. 1995 was the wettest year in recent history. There are no flow records for the seep for this year. Yet, the year features prominently in calibrating the model. d. The values of parameters were changed without justification, apparently to make the model "work." For example (first paragraph, page 6-12), waste was assigned a higher than usual hydraulic conductivity. However, to force the model to concentrate flows towards a seep, a hydraulic conductivity an order of magnitude greater was assigned to the same waste near the seep. No rationale, based on an assessment of waste properties, was provided for the selection and subsequent change of these parameters. Because current studies indicate that a prescriptive RCRA Subtitle C cover will be used for the Present Landfill, further work with this model appears not to be warranted. If however, a non-prescriptive cover is considered, additional work will be required to substantiate the results indicated by this model.	conclusions (i.e., groundwater flow paths, seep discharge, or water levels) changed due to relatively small changes in key model parameters. c. A significant amount of groundwater well water level data was available through much of the major recharge response (i.e. mid-1995). This information was very valuable in the calibration process. As such, seep discharge information would have only been somewhat useful. d. The decision to adjust some model cells immediately upgradient of the seep was made so that the integrated model could more accurately represent the water balance near the seep location. Without this modification, the grid resolution (50 feet), although finer than the SWWB model, is not fine enough to accurately define the local seep area morphology. Not modeling the seep with these cell modifications caused all of the seep discharge to be lost as evapotranspiration. This is simply due to the grid resolution. This modification is believed to be reasonable for the modeling objectives. The integrated model is capable of simulating the integrated effects due to the RCRA Subtitle C cover. As such, it can be used to estimate the surface runoff and near-surface evapotranspiration even for a RCRA cover. It can also be used to estimate the hydraulic response within the landfill waste area due to zero-infiltration. Furthermore, under a zero-infiltration scenario with a RCRA cover, the model would be able to estimate the increase in lateral groundwater inflow beneath the trench system due to increased hydraulic gradients in response to the decrease in waste levels due to loss of direct precipitation infiltration.
47	Appendix C. Appendix C discusses the water quality assessment for the Present Landfill. Section 2, Page 4, indicates that significant differences in groundwater quality still exist between wells up-gradient of and down-gradient from the East Landfill Pond. There is still no satisfactory and technically sound explanation of these differences. An evaluation should be conducted to explain the existing information and a clear concept of the hydrogeologic setting of this area should be developed. This report must include an explanation of the plans for the landfill pond and include surface water ramifications as well as wetland mitigation requirements. The unexplained and unanswered questions about contaminants beyond the pond suggest that additional monitoring may be necessary until these issues are resolved. The last paragraph of Section 2 refers to a seep interception system that discharges to the East Landfill pond. However, Figure 2 in the text indicates a groundwater intercept system that bypasses the East Landfill pond. Because it	The purpose of Appendix D is to provide an assessment of historical groundwater and surface water quality to support the IM/IRA. Plans for the landfill pond and wetland mitigation requirements are beyond the scope of this appendix. The seep intercept system described in Section 2 is not the groundwater intercept system shown in Figure 2 of the IM/IRA plan. This is clear from the description provided in Section 2. It is possible that the groundwater/leachate intercept system depicted in Figure 2 could discharge downgradient of the east landfill pond; however, historical groundwater quality data for groundwater beneath the landfill do not indicate that the landfill is the source of the salts observed in groundwater downgradient of the east landfill pond. This is the main conclusion of Section 4 of Appendix D. Although the source of the salts has been speculated over the years in the various annual groundwater reports (mineralization, evapotranspiration, etc.), it does appear that the landfill is not the source.

	was reported that portions of the base of the perforated and non-perforated sections of the intercept system both terminate in permeable unweathered bedrock, and the non-perforated section of the system is on the landfill-side of the slurry wall, it is not unlikely that the system is collecting and discharging contaminants down-stream from the East Landfill pond. Additional field-testing, such as tracer testing, may be required to obtain additional information to sensibly address this issue. This possible source of down-stream contamination must be addressed in this IM/IRA.	Therefore, presence of downgradient salts in groundwater does not affect closure of the landfill. However, the groudwater immediately downgradient of the East Landfill Pond will be evaluated in the RFETS Groundwater IM/IRA. Figure 2 does not indicate a groundwater intercept system that bypasses the East landfill Pond. The diagram indicates that the system was designed to drain the three different areas; the former west pond area, the landfill pond and to no-name gulch. What remains unclear from the available information is where discharge occurs, and whether it actually discharges. It is possible that the GWIS drain may only drain local groundwater from areas where levels are higher to areas that are lower, along its perforated lengths. The fact that a sand layer was placed along the entire length of the outer bank of the landfill trench (according to the as-built plans), in which the external GWIS drain was placed makes this more likely.
48	Appendix E. The Colorado Revised Statutes § 25-15-320, known as the Environmental Covenants Law, applies and is relevant and appropriate to the Present Landfill. These requirements should therefore be included in Appendix E and discussed in Section 6. Also, under the heading of RCRA, specific language should be added to the comment section to provide further clarity of regulatory requirements under Section 265.310(b), to include the following: "Compliance with Subsections (1) Maintain the integrity and effectiveness of the final cover, including making repairs to the cover as necessary to correct the effects of settling, subsidence, erosion or other events; (3) Maintain and monitor the ground water monitoring system and comply with all other applicable requirements of subpart F of 265; (4) Prevent run-on and run-off from eroding or otherwise damaging the final cover; and (5) Protect and maintain surveyed benchmarks…"	This comment is beyond the scope of the Present Landfill IM/IRA. The RFCA Parties are considering the needs and requests of all stakeholders after the completion of accelerated actions. However, the RFCA Parties are discussing the applicability of this statute to the federal government. Additionally, the proposed action for the Present Landfill presented in the IM/IRA is an accelerated action under RFCA; therefore, the Environmental Covenants Law is currently not considered an ARAR for the Present Landfill. Section 6.2 discusses in detail how section 265.310(b) will be met for this accelerated action.

Colorado Department of Public Health & Environment Comments
Draft Interim Measure/Interim Remedial Action (IM/IRA)
for Operable Unit 7 (IHSS 114) and RCRA Closure of the RFETS Present Landfill

Comment No. (Ref)	Comment	Response
	General Comment	
1	Will OU7 be closed in a final site-wide CAD/ROD or in a separate OU-specific CAD/ROD?	The area of OU7 will likely be addressed in a final site-wide CAD/ROD.
	Specific Comments	
2	Section 2.5.5 (p. 15) We understand that the modeling done to support this IM/IRA did not model the surface water because of the difficulties of quantifying the spray irrigation taking place in the model calibration period however we remain uncomfortable with the lack of accounting for surface water. We would like to see at least a back-of-the-envelope water budget including surface water inflows and outflows for the water year 2000 part of the modeling, which did not have spray irrigation.	The integrated model did simulate surface flow, but only overland flow. Preliminary modeling results showed that very little overland flow is generated in the model for the years simulated, except for near stream areas probably more associated with saturation excess (i.e,. groundwater saturation at surface). As a result, channelized flow was not explicitly defined, but overland flow still simulates the movement of water on the surface. The effects of the pond were included in the model, but dynamic pond levels were not simulated. Part of the problem with this was the uncertainty associated with spray irrigation, and pond discharges with time and the accuracy of pond levels with time.
3	Section 2.6.3.6 (p. 29) Well B206989 was also tested in the HR-ICP/MS uranium isotope study. Mass ratios were compared to natural ratios of U235/U238 and a significant ratio of U236/U238 to establish the natural origin of the dissolved uranium in ground water. This study also shows a sample from SW097 to have a very low concentration of uranium, but it has a contaminant signature in both ratios. This information was published by the site in the 2001 Annual RFCA Groundwater Monitoring Report, although additional work by CDPHE (not published) has lowered the significant level of the U236/U238 ratio.	A reference to the HR-ICP/MS study and well B206989 will also be included in the fourth paragraph under this section. An additional paragraph will be added to discuss the results associated with SW097 and a comparison to RFCA surface water standards.
4	Section 4.1.3 (p. 42) and Section 5.1 (p. 53) The RCRA Subtitle C Guidance Cover should also include: • geotextile filter above the drainage net to keep it from clogging • cushion layer between surface of landfill and GCL • passive gas venting system. The FML should preferably be HDPE rather than PVC. If the cushion layer is sufficiently permeable, it could also serve as a gas venting layer.	These items will be addressed as a part of the detailed design of the proposed action.

5	Section 5.1 (p. 53) Surface water runoff from this cap needs to be modeled and a surface water management plan designed. Weed control is likely to become a significant issue in maintaining this cover. Herbicides used to control noxious weeds could easily contaminate surface water without adequate planning.	These items will be considered as a part of the detailed design of the proposed action. The need for weed control measures is discussed in Section 6 and the ARARs table, including the use of herbicides, and further details will be provided in the Monitoring and Maintenance Manual.
6	Section 5.2 (p. 54) The first sentence in this section should clarify that this is a description of the existing seep treatment system, which will be modified.	The text will be revised to present the modifications proposed for the seep treatment system. The major modification will be the passive aeration of the seep within a tank prior to discharge of the treated seep water into the East Landfill Pond.
7	Section 6.0 (p. 58) The Colorado Revised Statutes § 25-15-317 to 327, known as the Environmental Covenants Law, apply and are relevant and appropriate to the Present Landfill. These requirements must therefore be included in Appendix E and discussed in Section 6.	The RFCA Parties are discussing the applicability of this statute to the federal government. The proposed action for the Present Landfill presented in the IM/IRA is an accelerated action under RFCA; therefore, the Environmental Covenants Law is currently not considered an ARAR for the Present Landfill
8	Section 6.2.2.3.2 (p. 62) Well 02097 in the PU&D Yard plume showed evidence of methane that could have migrated from the PLF along the fracture zone associated with the fault hypothesized in the 1995 Geologic Characterization Report. This well and another to the north of the landfill in the fracture zone if it exists, possibly 7187, should be added to the ground water monitoring network for the landfill.	The 2000 Annual RFCA Groundwater Monitoring Report indicates in the plume degradation monitoring section, that well 02097 detected 17,000 µg/L of methane. This sample result was collected in 2001 and both the 2000 and 2001 annual reports indicate that additional sampling and analysis should verify this high methane value. Methane is a degradation product associated with various organic compounds. It is believed that this high concentration is the result of the degradation associated with the treatability study being conducted at the PU&D yard. However, additional research has been done to determine if this high concentration of methane can be verified through additional sampling and analysis. In March 2002, a sample was collected for methane analysis at well 02097 and results were 370 µg/L. A laboratory qualifier indicated that the concentration of this compound exceeded the calibration range. In July 2002, an additional sample was collected and results indicate a concentration of methane at 500 µg/L. In 2003, two additional samples were collected for methane analysis. In January 2003 the methane results for well 02097 were 740 µg/L and in August 2003 the results were 35.1 µg/L. Prior to 2001 plume degradation monitoring was not conducted and methane analysis was not included in the analysis performed on well 02097. Although sampling and analysis of this well continues to show concentrations of methane to be present in well 02097, sampling and analysis has verified that a

		high methane concentration does not exist at well 02097. As additional consideration, the Inferred fault lies beneath the waste fill material and the waste fill material is located within a zone of saturation. It is not typical that gas generated within the landfill would travel downward through a zone of saturation. Methane gas generated within the landfill would typically rise above the zone of saturation and escape through a path of least resistance. Since this well exists within the PU&D yard plume it is not recommended that this well be included in the Present Landfill RCRA groundwater monitoring system. Well 7187 has not been sampled since 1995 and is scheduled for abandonment in 2004.
9	Section 6.5.2 (p. 65) Sub-section 6.5.2.1 should clarify that this is a description of the existing seep treatment system, which will be modified. Sub-sections 6.5.2.1 and 6.5.2.3 should also state that the monitoring/compliance point for NPDES purposes will be at the discharge from the WWTU tank system.	Text will be modified to state that the monitoring/compliance point for NPDES purposes will be at the discharge from the WWTU tank system.
10	Section 6.5.3 (page 66) This section describes the passive seep treatment system, which does not precisely meet the WWTU requirements in its current configuration. The description can be generalized, but must clarify that the existing seep treatment will be modified so that treatment will occur in a tank. Changes to the following four paragraphs are suggested in order to more precisely describe the physical and regulatory aspects of the seep treatment system.	The text will be revised to present the modifications proposed for the seep treatment system. The major modification will be the passive aeration of the seep within a tank prior to discharge of the treated seep water into the East Landfill Pond.
11	*1st paragraph:* The Present Landfill seep discharge contains landfill leachate that is mixed with groundwater. Since the discharge from the Present Landfill seep ~~discharge is~~ treatment system will be regulated under NPDES, it is not a solid waste and therefore not a hazardous waste at the point where it is a regulated NPDES discharge (Section 261.4(a)(2) of 6 CCR 1007-3~~) (which, u~~ . Under CERCLA, this NPDES discharge is eligible for a permit waiver as described in sections 6.5.1 and 6.5.2~~)~~.	The text will be modified to incorporate the changes as suggested.
12	*4th paragraph:* In the current configuration of the seep treatment system, Present Landfill seep water is intercepted in a perforated pipe that directs water to a concrete tank, which serves as a settling basin. Dense solids settle in the basin and the remaining water is directed to a steel vault where the Present Landfill seep flow is measured. Water then flows over flagstone steps (waterfall) before	The text will be modified and include the planned modifications to the treatment system.

	flowing into the East Landfill Pond. ~~This is the wastewater treatment unit for the Present Landfill seep~~. In order to meet the requirements for a waste water treatment unit exclusion, this system will be modified so that treatment will occur within a tank.	
13	*Last 2 paragraphs:* In the existing seep treatment system, ~~T~~the Present Landfill seep ~~flows~~ is collected in 4-inch slotted pipes from the bottom of the east face of the Present Landfill, then flows through a 4-inch PVC ~~perforated~~ pipe~~,~~ into a precast concrete tank (6-foot wide, 12.5 feet long, 7 feet deep) to settle any dense solids ~~from the Present Landfill seep flow~~. Present Landfill seep water ~~flow from this tank~~ then flows into another 10-foot diameter steel vault ~~that~~ where a flow meter measures ~~Present Landfill~~ seep ~~flow~~ volume. Water from this final tank flows by gravity through a 4-inch PVC pipe into ~~the~~ a passive aeration system (flagstones) ~~through a 4-inch PVC pipe~~ (See~~,~~ Figure 5~~.~~). The system meets the 260.10 definition of a tank or tank system and is a dedicated part of the WWTU. The seep treatment system will be modified to meet the requirements of a WWTU so that treatment will occur within a dedicated tank or tank system, as defined in 6 CCR 1007-3 §260.10.	The text will be modified to incorporate the changes as suggested.
14	Section 7.3 (p. 72) Adding the new section heading for Section 7.2 - Impacts to Surface Water left this document with two sections 7.3 in the text and in the Table of Contents.	Corrections will be made to text to clarify the section designations.
15	Section 8.0 (p. 76) The former sections discussing physical and institutional controls have been reduced to a line in Table 7. The specific, anticipated physical and institutional controls that will be part of this remedy and how they will be implemented need to be outlined in this decision document. These controls may change by the time they are implemented and reported in the closeout report and institutionalized in a CAD/ROD, but they should be clearly anticipated and outlined in this document.	Physical and institutional controls have been discussed in various sections of the IM/IRA. Table 7 is a summary of the discussion in the text. Details of post-action monitoring and maintenance will be presented in the Monitoring and Maintenance Plan prepared after the completion of the detailed design. Appendix A has been added to describe the elements of post-accelerated-action monitoring, institutional controls and long-term stewardship.
16	Section 4.0: This section should state that the presumptive remedy for the Present Landfill is a cover that is compliant with RCRA C requirements. Discussions of each of the cover designs in the alternative analysis, therefore, should demonstrate how that cover will be RCRA C compliant.	All three alternatives evaluated in the IM/IRA meet the project RAOs, one of which is to achieve RCRA interim status closure (RCRA subtitle C compliant) and all are containment remedies that are consistent with the presumptive remedy for a landfill. Additional text will be considered to

		clarify this point.
17	Section 4: RFCA paragraph 118 includes design plans on the list of approvable documents. Since the IM/IRA presents concepts, but not details of the proposed cover, those details must be presented for approval in the final design document. A statement to the effect that these design details will be available for approval in that document should be included in the IM/IRA.	The text of the IM/IRA in Section 4 will be modified to include that the review and approval of the final design will be done by the regulatory agencies. The design of the accelerated action will provide detailed design drawings, specifications and quality control procedures for the construction of the cover.
18	Section 6.2.2.3.2-Maintain and Monitor the Groundwater Monitoring System: The groundwater monitoring period proposed in this section is 2 years. However, the presumption for groundwater monitoring must fulfill the Colorado Hazardous Waste Regulations in 265.117. These regulations call for the post-closure monitoring, maintenance and reporting to continue for a period of 30 years, which may be shortened or extended by the RFCA parties based on monitoring results. It has not been shown that the existing downgradient wells can meet the requirements for groundwater monitoring in 265.90. These wells must be capable of yielding groundwater samples to detect hazardous waste that has migrated to the uppermost aquifer and they should be located as close as possible to the boundary of the landfill.	The IM/IRA will be modified to reflect a 30 year monitoring period for groundwater monitoring, recognizing that the regulatory agency may shorten this period, if a reduced period is sufficient to protect human health and the environment. This evaluation will be conducted during the CERCLA periodic review period and may be shortened by the RFCA parties based on monitoring results. RCRA Interim Status groundwater monitoring has been conducted at the Present landfill since 1986, when pursuant to the 1986 RCRA Compliance Order and CERCLA Agreement 4 wells were installed at the Present Landfill: 2 upgradient and 2 downgradient at the toe of the landfill. By 1987, 20 additional were located upgradient and downgradient of the landfill. In 1988, based upon an examination of water quality data from wells within and surrounding the landfill, an alternate groundwater monitoring system (6 CCR 1007-3; 265.90(d)) was implemented and has monitored downgradient groundwater quality for impacts from the landfill. In accordance with RFCA, the adequacy of well placement is evaluated in the annual IMP reviews. The wells associated with this alternate groundwater monitoring system were placed downgradient of the East Landfill Pond, below the dam. (It is noted, that historically two wells were located between the Present Landfill and the East Landfill Pond, however they were removed in anticipation of placing a cover over the Present Landfill and they were typically dry or yielded samples of insufficient quantity to perform chemical and radiological analysis.) Historically since 1986, groundwater monitoring at the Present Landfill has been in compliance with RCRA Interim Status requirements. Near the Present Landfill groundwater flows from hilltop ridges to nearby streams. Based upon the Conceptual Flow Model, groundwater at the Present Landfill is also redirected locally toward the landfill trench system, which includes the Groundwater Intercept System (GWIS), landfill drain system and clay barrier. As a result, water flows through the groundwater system and primarily discharges through the seep. At the Present Landfill seep, groundwater discharges to the surface from both the unconsolidated material and the underlying weathered bedrock (conceptualized as claystone/siltstone). All saturated zone flow upgradient of the Present Landfill seep is

		conceptualized as discharging at the surface, or immediately downgradient of the Present Landfill seep. As the conceptual flow model indicates, releases to the uppermost aquifer have been controlled by the landfill trench system. This has resulted in groundwater monitoring wells immediately downgradient of the landfill and below the dam to occasionally be dry or not capable of yielding samples of sufficient quantity for analysis, because a majority of groundwater flow discharges at the surface. The existing downgradient RCRA groundwater monitoring wells are located directly within the drainage area, they are directly downgradient from the Present Landfill, and they are located as close as practical to the unit. Existing wells are currently located further down No Name Gulch (approximately 400-600 feet further downgradient), which are capable of yielding sufficient samples and could be included as a Present Landfill RCRA groundwater monitoring well, however they not located close to waste disposal boundary of the landfill. Thus, like the current downgradient well locations, ground water at these locations could be impacted by other potential sources.

Rocky Flats Citizens Advisory Board Comments
Draft Interim Measure/Interim Remedial Action (IM/IRA)
for Operable Unit 7 (IHSS 114) and RCRA Closure of the RFETS Present Landfill

Comment No. (Ref)	Comment	Response
	Present Landfill IM/IRA - Executive Summary	
1	Many of our comments are aimed at gaining a better understanding of the proposal and its implications for the future. Along those lines, we would ask that the Executive Summary include a brief explanation of what prompted the change from the evapotranspiration cover proposed last year to the current proposal to install a RCRA Subtitle C cover.	The evaluation of the cover alternatives considers the overall short-term and long term impacts of action and considers that the long term maintenance requirements of the proposed action are generally less than the short term negative impacts of the ET cover. Section 4.0 of the IM/IRA specifically discusses and calculates the additional safety risks associated with the construction of an ET cover. Clearly, the additional vehicle-miles required to build the ET cover and the associated accident rates is less for the proposed geosynthetic cover alternative that uses more common materials located closer to the RFTES facility. Additional text will be added to the executive summary to clarify selection of the RCRA Subtitle C cover.
2	The Board would also like justification for the discrepancy between the data identifying the ratio of groundwater inflow and precipitation infiltration in the current document from previous site documents. Previously, it was stated that lateral groundwater inflow contributed as much as 40% to the seep flow, whereas the hydrologic modeling done this year estimates the groundwater contribution to be less than 10%.	The discrepency between results of the current modeling and former modeling regarding the ratio of infiltration to lateral groundwater inflow is due to significant differences between the two models. These differences are highlighted below: Former Model: a) Modflow groundwater flow model. b) Boundary conditions: - lateral conditions (constant head, general head) - recharge – calibration parameter (estimated) - evapotranspiration – apparently not considered - seepage – drain/constant head - Pond – constant head c) Steady state model (10000 yr transient model with no time-varying stresses, or boundary conditions), d) Grid resolution 50 feet by 50 feet e) Model Area (smaller than current model to the west, north and south) f) Vertical model layers (2 layers - 1 for alluvium and 1 for weathered bedrock)

		g) Top and bottom of weathered bedrock surface – GIS data available at the time (pre-1995) h) GWIS system – simulated as a drain i) Trench clay barrier – apparently not considered j) Internal Trench collection trench (gravel layer, 5' thick at base of trench) – apparently not considered? k) Calibration to only average annual groundwater heads and seep discharge. Difficulty with bedrock wells. Current Model: a) Integrated flow model simulates the dynamic coupling of overland flow, unsaturated zone and saturated zones. b) Boundary Conditions - Utilized actual time-varying climate data; 15-minute precipitation, temperature, and hourly potential evapotranspiration based on time-varying wind speed, humidity, solar radiation and temperature. - Included effects of snowmelt and subsequent runoff - Included effects of spatially and temporally varying annual vegetation dynamics on unsaturated zone behavior – i.e., calculated actual evaptranspiration, soil evaporation and transpiration, - Spatial and temporal variability of recharge to groundwater is calculated in this model based on climate variability and unsaturated zone dynamics, including evapotranspiration. This is a complex boundary condition. c) Transient integrated model – Used actual time-varying climate information at the precipitation event-level. d) Grid resolution 50 feet by 50 feet e) Model Area (larger than former modflow model on the north, south and west sides) to reduce boundary effects on internal calculations. Also considered more realistic surface and subsurface boundary conditions than former model (i.e., typically groundwater divides) f) Four saturated zone layers. This accounted for waste material, unconsolidated material beneath waste and beneath landfill trench, and for weathered bedrock. g) GWIS drain, clay barrier and internal gravel drain were all simulated in the integrated model explicitly. h) A considerable effort was made to obtain all available information on the weathered bedrock surface. The GIS database used to define this

		surface and the bottom of the weathered bedrock represent the most comprehensive to date. This is a key surface in the modeling. i) Calibration to: • Seasonal heads, • Average annual heads (unconsolidated and bedrock) • Seep discharge, • Qualitatively – overland flow (minimal) The integrated model accounts for more hydraulic features, has more model layers, and more correctly simulates actual integrated system processes than the former modflow-groundwater model. Model results from former modflow modeling did not include ET, the largest discharge component of the water balance in the area. Including ET in the current model results in a more reliable model. In the former modflow model, spatially uniform and temporally constant recharge rates are assumed, rather than calculated as in the integrated model. Despite the range of hydraulic conductivity values for unconsolidated material at RFETS, these values were held constant during calibration, while recharge was adjusted to match observed annual average heads (unknown how this is averaged). No effort was made to estimate recharge rates that would be obtained if hydraulic conductivity values in the model had been adjusted, even slightly. It is well known that varying recharge and hydraulic conductivity lead to non-unique model solutions. In otherwords, if recharge is increased, hydraulic conductivities could also be increased such that heads are still matched. Therefore, the total recharge could be several times higher (or lower) than actual rates, depending on what hydraulic conductivity values are used, and the heads could be matched equally well. As a result, there is no basis for concluding that calibrated 'recharge' values are obtained in the former Modflow modeling. Moreover, by not having simulated unconsolidated material (including waste) with at least two layers in the former modeling, it is not possible to simulate lateral groundwater flow accurately within the unconsolidated material beneath the waste, or beneath the northern side of the landfill trench where the recent modeling work more accurately estimates interpolated weathered bedrock depths (i.e., more data). Finally, not explicitly simulating the internal landfill drain, or the clay

		barrier severely limits the ability of the former model to evaluate groundwater response anywhere near the landfill trench system (especially in light of the lack of ET, and poor calibration of recharge and hydraulic conductivities). The former model is therefore, unable to accurately or realistically predict groundwater performance within, or external to the waste area, for current, or future cover conditions. Because the former model simulates a single drain that allows inflow from the waste and groundwater external to the trench, the amount of recharge is likely overestimated within the waste area to produce observed seep discharge. In otherwords, the drain pulls groundwater from the waste side, that would have eventually discharged to the seep as the current integrate model predicts. Ultimately, this makes the entire water balance in the former modflow modeling (especially in terms of estimating the ratio of recharge to lateral groundwater inflow) inaccurate, unrealistic and unreliable. The former modeling report also suggests the trench on the north side and possibly south side is breached. However, this is assumed based on similar groundwater levels. This assumption is however, not valid, as it is possible that similar heads may occur due to similar recharge rates. A breach could only be confirmed through hydraulic testing, tracer testing, or through geochemical fingerprinting. None of these were performed and the concept of a breach, consequently remains only an assumption.
3	RFCAB recommends collecting field data to verify the modeling conclusions.	Because the model was calibrated using existing data and a sensitivity analysis was performed, RFETS is confident that the fully integrated model accurately depicts the behavior of the groundwater at the landfill.
	Long Term Stewardship – Monitoring – Cover Performance	
4	The site should consider using hydrologic cover performance monitoring to verify whether the cover is functioning as intended in the post-closure period (i.e. the minimum hydraulic conductivity is being attained).	The proposed accelerated action implements the CERCLA presumptive remedy of source containment. RCRA interim status closure performance standards have been identified as ARARs in Appendix F and are discussed in Section 6.1, and includes a RCRA Subtitle C equivalent cover.. A RCRA Subtitle C cover is designed to minimize infiltration through the cover, promote drainage, function with minimal maintenance, accommodate settling and have a permeability less than the existing subsoils present beneath the landfill. As specified within these regulatory requirements, compliance with RCRA Subtitle C design

		standards ensures that a facility is closed in a manner that is protective of human health and the environment. As a result, additional performance monitoring of a RCRA Subtitle C cover is not required. Additionally, the geosynthetic composite cover proposed for the landfill is a robust multilayer cover with component design specifications based upon limiting infiltration to less than 1.3 mm/year. Because the cover will be constructed in accordance with these specifications, lysimeters or other seepage measurements under the cover are not required.
5	The site should justify any decision not to conduct direct monitoring of cover performance.	See response to comment No. 4. Post-accelerated action groundwater and seep waster quality monitoring will also be conducted for the Present Landfill as described in Appendix A.
6	If the site intends to rely on leachate flow to determine the integrity of the cap, the IM/IRA should identify seep flow rates to trigger evaluations and additional monitoring of the effluent.	The proposed action does not use seep water flow to determine the integrity of the cover. The reason for this is that once infiltration through the cover has been minimized (estimated to be 90% of seep flow), the model predicts an increased hydraulic gradient toward the internal landfill gravel drain and discharge at the seep. As a result, it is anticipated that seep flow will initially decline and then reach a steady flow rate equal to lateral flow plus a small vertical recharge. Maintaining the integrity of the cover is discussed in the IM/IRA (See Appendix A).
	Long Term Stewardship – Monitoring - Seep	
7	RFCAB finds the sampling proposed for the seep unacceptable. At the October 23rd ER / D&D meeting, the site indicated that the RFCA parties will consult after four years to see whether further seep sampling is warranted. The burden of proof should be on DOE to justify discontinuance of sampling, not the other way around. A thorough data analysis should dictate the sampling period, not an arbitrary time frame.	The IM/IRA (See Appendix A) describes the monitoring requirements for the seep. The text states that during the CERCLA periodic review, the RFCA Parties will evaluate whether continued monitoring is required after a proposed sampling period. The time frame itself does not mean that sampling could discontinue automatically. The evaluation will include a thorough data analysis. The text of the IM/IRA will be modified to present that seep monitoring will occur quarterly. The RFCA parties can adjust the frequency of sampling; however, based on the regulations, the monitoring frequency will be at least annually.

8	For the first year, the seep should be monitored monthly rather than quarterly. The purpose of more frequent monitoring is to establish seasonal and long-term trends using sufficient data points.	The IM/IRA (See Appendix A) describes the monitoring requirement for the seep. Monitoring will be conducted quarterly which will provide sufficient data points to determine seasonal and long-term trends.
9	The seep should be monitored at both influent to and effluent from the treatment unit to determine the effectiveness of the treatment unit.	The IM/IRA (See Appendix A) describes the monitoring requirements for the seep. This section will be modified to include influent seep sampling and analysis at the same frequency and for the same constituents as the effluent.
10	The treatment tank effluent should be a RFCA surface water point of compliance, as it is a discrete conveyance of pollutants to waters of the State.	The treatment tank is part of the accelerated action and the treatment tank effluent is regulated under the IM/IRA. RFCA does not envision creating a new surface water point of compliance for the treatment tank effluent. The NPDES outfall for the treatment tank is at the point of discharge from the treatment tank.
11	A suite of analytes, as identified by the Integrated Monitoring Plan, should be monitored until there are sufficient data points to ascertain whether the leachate contains slower migrating pollutants. An evaluation of the data during the review could modify the sampling methodology.	The constituents currently associated with the Present Landfill seep and identified in this decision document are benzene and vinyl chloride. RFCA parties determined, based on historical monitoring data for the seep, that good indicator parameters for changes in the seep water quality are VOCs and metals. If in the future statistically significant changes to the seep water quality are observed, the RFCA Parties will evaluate if the monitoring program or the treatment system should be changed.
12	Parameters should be identified for data analysis to determine when evaluations and/or corrective actions should be taken.	Parameters and when to evaluate are specified in Section 6.4.2.3. Specifically, this section states, "The effluent limits are the surface water standards applicable for the receiving water as listed in RFCA Attachment 5, Table 1. Continued exceedances during a three month period will trigger consultation between the RFCA parties to evaluate whether a change to the remedy is required, additional parameters need to be analyzed or if different sampling frequency is required."
13	Additional sampling required such as the Whole Effluent Toxicity (WET) Test, Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) shall be performed per the guidelines of effluent discharge into waters of the state.	These are not chemical specific standards for which stream standards exist. Instead these are a class of discharge conditions that may indicate an impact to receiving water. There is no evidence of these conditions having an impact on the East Landfill Pond. In addition, we have established that we do not have levels (in part per million or ppm) of any contaminant that would trigger these kind of conditions. We already know that based on water quality for the Present Landfill seep and East Landfill Pond water, that BOD and COD would not be exerted at levels of environmental concern.

14	The source point of discharge shall be an enforceable compliance point with identified standards and penalties.	The treatment tank is part of the accelerated action and the treatment tank effluent is regulated under the IM/IRA. Per Section 6.4.2.3., the effluent limits are the surface water standards applicable for the receiving water as listed in RFCA Attachment 5, Table 1.
15	The source point of discharge should be at the effluent discharge of the treatment tank.	The NPDES outfall for the treatment tank is at the point of discharge from the treatment tank.
16	Local governments and the communities should be informed when an evaluation is implemented.	This decision document and the IMP are implemented under the CERCLA process and since this is a CERCLA action, the public would be informed.
	Long Term Stewardship – Monitoring - Groundwater	
17	The post-closure monitoring period should be a minimum of 30 years. The State of Colorado regulations pertaining to Municipal Solid Waste Landfill Units (6 CCR 1007-2, Subsection 3.6.3) state that: "Post-closure care must be conducted for a minimum of thirty years (30) years." RFCAB understands that this period may be reduced or increased, based on site-specific circumstances relative to protecting human health and the environment, and further, that these requirements do not directly apply to Present Landfill. However, we believe the monitoring regime for a RCRA Subtitle C landfill should be at least as stringent as that required for a solid waste landfill.	The landfill has been in existence for 35 years, groundwater monitoring has been ongoing for 30 years and RCRA groundwater monitoring has been ongoing for 17 years (A summary is provided in Appendix B). Historical groundwater monitoring data indicate there is no impact to downgradient groundwater quality resulting from the Present Landfill. The conceptual flow model as discussed in section 2.5.7.1 supports these analytical results. The flow model indicates that all saturated zone flow upgradient of the Present Landfill seep is conceptualized as discharging at the surface at, or immediately downgradient of, the Present Landfill seep (the Present Landfill Pond). Additionally, the groundwater immediately downgradient of the East Landfill Pond will be evaluated in the RFETS Groundwater IM/IRA. The post-accelerated action period for the Present Landfill will be identified initially as 30 years, recognizing that the regulatory agency may shorten this period, if a reduced period is sufficient to protect human health and the environment. This evaluation will be conducted during the CERCLA periodic review period.
18	The site should justify any proposed reduction of the 30-year post-closure monitoring period. Historical data alone would not be sufficient to demonstrate a lack of migration potential because it may not be representative of modified groundwater movement after the placement of the cap.	The post-accelerated action period for the Present Landfill will be identified initially as 30 years, recognizing that the regulatory agency may shorten this period, if a reduced period is sufficient to protect human health and the environment. This evaluation will be conducted during the CERCLA periodic review period.
19	A suite of analytes, as identified in the Integrated Monitoring Plan, should be analyzed annually as a minimum until the first CERCLA review is performed to gather sufficient data points to evaluate the monitoring criteria. The rationale for	In 1986 groundwater monitoring focused on compliance with RCRA requirements and 20 wells were located upgradient and downgradient of the Present Landfill Operable Unit 7 and sampling included the hazardous substance list VOCs, SVOCs, metals, major ions and radionuclides. This

	our recommendation is based on the concern that pollutants may migrate slowly from the landfill and impact groundwater quality.	was done in accordance with the 1986 RCRA Compliance Order and CERCLA Agreement and had the approval from both regulatory agencies. Historical locations and analytical programs are summarized in Appendix A and were always conducted under a compliance order and/or agreement that involve both regulatory agencies. In July 1996, when RFCA was adopted, the entire RFETS groundwater monitoring network (including 25 wells around the Present Landfill) was evaluated, to align the RFETS groundwater monitoring program with the new RFETS mission and RFCA requirements. A data quality objective (DQO) process was used to determine the decisions that were necessary for groundwater and the function of each well in the network in supporting those decisions. DOE, CDPHE and EPA were directly involved in decisions involving the monitoring network and which selected the current 8 RCRA wells for the Present Landfill and the suite of analysis to be performed. Results of this evaluation are presented in the 1996 Annual RFCA Groundwater Monitoring Report. The location of these 8 RCRA wells and the analytical parameters VOCs and metals, which are currently proposed for continued groundwater monitoring, were approved by the regulatory agencies. In addition, the RFCA parties determined, based on historical monitoring data, that good indicator parameters for changes in groundwater quality are VOCs and metals.
20	The proposal calls for continued use of the existing network of Integrated Monitoring Plan groundwater wells. The Board is concerned that these may not be optimally located. Therefore, we recommend that the groundwater well locations be reevaluated to ensure that the placement of downgradient wells is optimal in terms of identifying any potential migration from the landfill.	RCRA Interim Status groundwater monitoring has been conducted at the Present landfill since 1986, when pursuant to the 1986 RCRA Compliance Order and CERCLA Agreement 4 wells were installed at the Present Landfill: 2 upgradient and 2 downgradient at the toe of the landfill. By 1987, 20 additional were located upgradient and downgradient of the landfill. In 1988, based upon an examination of water quality data from wells within and surrounding the landfill, an alternate groundwater monitoring system (6 CCR 1007-3, 265.90(d)) was implemented and has monitored downgradient groundwater quality for impacts from the landfill. In accordance with RFCA, the adequacy of well placement is evaluated in the annual IMP reviews. The wells associated with this alternate groundwater monitoring system were placed downgradient of the East Landfill Pond, below the dam. (It is noted, that historically two wells were located between the Present Landfill and the East Landfill Pond, however they were removed in anticipation of placing a cover over the Present

		Landfill and they were typically dry or yielded samples of insufficient quantity to perform chemical and radiological analysis.) Historically since 1986, groundwater monitoring at the Present Landfill has been in compliance with RCRA Interim Status requirements. Near the Present Landfill groundwater flows from hilltop ridges to nearby streams. Based upon the Conceptual Flow Model, groundwater at the Present Landfill is also redirected locally toward the landfill trench system, which includes the Groundwater Intercept System (GWIS), landfill drain system and clay barrier. As a result, water flows through the groundwater system and primarily discharges through the seep. At the Present Landfill seep, groundwater discharges to the surface from both the unconsolidated material and the underlying weathered bedrock (conceptualized as claystone/siltstone). All saturated zone flow upgradient of the Present Landfill seep is conceptualized as discharging at the surface, or immediately downgradient of the Present Landfill seep. As the conceptual flow model indicates, releases to the uppermost aquifer have been controlled by the landfill trench system. This has resulted in groundwater monitoring wells immediately downgradient of the landfill and below the dam to occasionally be dry or not capable of yielding samples of sufficient quantity for analysis, because a majority of groundwater flow discharges at the surface. The existing downgradient RCRA groundwater monitoring wells are located directly within the drainage area, they are directly downgradient from the Present Landfill, and they are located as close as practical to the unit. Existing wells are currently located further down No Name Gulch (approximately 400-600 feet further downgradient), which are capable of yielding sufficient samples and could be included as a Present Landfill RCRA groundwater monitoring well, however they not located close to waste disposal boundary of the landfill. Thus, like the current downgradient well locations, ground water at these locations could be impacted by other potential sources.
21	Groundwater wells should be compliance points with identified standards that are enforceable.	The IM/IRA states that eight (four upgradient and four downgradient) RCRA groundwater monitoring wells have been established for the Present Landfill pursuant to RFCA and RCRA. The IM/IRA also states that the existing downgradient RCRA groundwater monitoring wells will be groundwater POC wells for RFCA Attachment 10. And that groundwater sampling results

		will be evaluated in accordance with RFCA Attachment 5, Section 3.0 for groundwater.
22	Parameters should be identified to determine when an evaluation or corrective action should be taken.	During a 35-year period the Present Landfill has shown little impact to downgradient groundwater quality prior to closure. The proposed action in this IM/IRA is to close the Present Landfill by placing a RCRA subtitle C equivalent cover over the landfill, which is designed to minimize infiltration through the landfill and provide an overall positive impact to groundwater quality. No significant impact to groundwater quality is expected from this action, since no significant impact to downgradient groundwater quality is currently observed. Post-accelerated action monitoring of this landfill will continue to determine changes in downgradient groundwater quality. Groundwater monitoring data will be evaluated in accordance with RFCA Attachment 5, Section 3.0 to determine if any additional actions are required.
23	The site proposes not to calculate alternate concentration limits (ACLs) for groundwater, as provided for in RFCA Attachment 10. RFCAB understands that ACLs are risk-based contaminant levels calculated to be protective of surface water. RFCAB recommends that ACLs be calculated for the Present Landfill area. This would provide greater assurance that groundwater in the area would continue to be of sufficient quality to prevent adverse effects on surface water.	DOE is adhering to the requirements of RFCA pertaining to the Present Landfill. Section 6.2 discusses RFCA Attachment 10. RFCA Attachment 10 allows for the calculation of DCLs and ACLs, but does not require that DCLs or ACLs be calculated. The Present Landfill is not contaminating groundwater, except for groundwater exiting at the seep. The seep is not impacting surface water quality at the East Landfill Pond. The originally proposed and modified proposed cover is a cover equivalent to RCRA Subtitle C requirements. Neither cover design was based on a specific DCL calculation, but rather upon a design infiltration rate that meets RCRA Subtitle C requirements and guidance criteria. Because groundwater is not impacting surface water and the proposed cover will perform better than the current soil cover, no DCLs are calculated. The conclusion of section 2.6.3 is that groundwater from the landfill is not impacting surface water quality. Therefore, no ACLs are calculated.
24	Local governments and the communities should be informed when an evaluation is implemented.	This decision document and the IMP are implemented under the CERCLA process and since this is a CERCLA action, the public would be informed.
	Long Term Stewardship – Monitoring - Inspections	
25	The Board has concerns with the frequency of physical inspections. In the near term, until vegetation is established in the drainage ditches, the Board urges that inspections occur on a regular basis. Also, the regular inspection schedule should be augmented whenever there is a precipitation event that results in overland flow of water. These inspections should include inspections of the cap, associated	Monitoring of the erosion, subsidence and cover integrity at the landfill after the action is completed will be conducted on a quarterly basis or as needed based on weather conditions and previous inspection reports. Appendix A identifies the engineered controls, including inspection and

	drainages, and pond to determine the extent of erosion damage, subsidence, or pond integrity.	reporting requirements and frequencies, which will be implemented for the proposed action. Details of maintenance and inspection will be included in the Maintenance and Monitoring Plan.
26	The subsidence criterion of two feet quoted by the site at a recent RFCAB meeting is unacceptable. Depending on the design specifications, a lesser degree of settling could compromise the integrity of the cover.	The potential subsidence and differential settling will be predicted as a part of the detailed design. The design of the accelerated action will provide detailed design drawings, specifications and quality control procedures for the construction of the cover consistent with these prediction calculations.
27	The document should include the requirement of settlement monuments on the cap to measure subsidence criteria.	Settlement monuments will be evaluated in the detailed design.
28	The document should identify weed management criteria to protect the cap. If herbicides are used, they should be evaluated to determine their effect on water quality.	Appendix A identifies the engineered controls, including inspection and reporting requirements and frequencies, which will be implemented for the proposed action, including vegetation control. Details of maintenance and inspection will be included in the Maintenance and Monitoring Plan.
29	The inspections should have measurable data quality objectives to ensure that regulatory criteria are being met.	The objectives and criteria of post-action monitoring are summarized in Appendix A of the IM/IRA. Details of maintenance and inspection will be included in the Maintenance and Monitoring Plan.
	Long Term Stewardship – Monitoring – Security / Site Control	
30	Signs should be placed around the landfill area to identify the area and inform humans of the landfill siting.	A new section 6.1.4., will be added, titled, "Closure Activities". In this section the following paragraph will be added: "Site security will be maintained during and after construction activities. Signs will be posted warning of potential danger at the landfill."
31	To ensure protection of the cap, pond, and monitoring stations, CAB is adamant a fence should be maintained around the landfill area. The fence will prevent access to the general public and provide controls of the monitoring stations.	Institutional controls as described in Appendix A of the IM/IRA are proposed to control access to the site. No fence around the Present Landfill is proposed in this action.
32	DOE must ensure that refuge activities are prohibited at or near the landfill.	As stated in Appendix A, Post-accelerated action institutional controls for

		RFETS as a whole are currently being evaluated by DOE and the regulatory agencies, and in consultation with the Fish and Wildlife Service and the community. This includes prohibiting roads and trails on the cover or the immediate vicinity of the cover. Institutional and physical controls for the Present Landfill are presented in Appendix A. The Appendix states, "DOE will retain jurisdiction over the engineered controls associated with the proposed action." and addresses DOE's responsibility as the controlling authority for the area covered by the proposed action.
	Long Term Stewardship – Monitoring - Maintenance	
33	How will the cover be maintained? How often will its degradable components need replacement?	Cover maintenance is presented in Appendix A of the IM/IRA. It is not anticipated that the components of the cover will need to be replaced since they are protected from the weather elements and degradation of the cover from the landfill wastes is not expected.
34	Deep-rooted trees should be removed manually, rather than with herbicide, in order to protect water quality in the drainage.	Vegetation control on the cover will be manual or by a herbicide that is approved by DOE and the regulators.
35	Include the general Contingency Plan for the cap and what parameters will be measured to determine when actions need to be taken. The plan at a minimum should include: • Maximum size of area with erosion that will require repair of the cap • Settlement/subsidence – based on monuments, at what point will the cap have to be repaired? • The length, width and/or depth of cracks that will require repair of the cap • The criteria to determine if burrowing animals have impacted the cap • The criteria for the rip/rap layer and the corrective measures to prevent ponding, vegetation growth, and settlement. • Breach of monitoring stations • Breach of trespassing	The development of a Contingency Plan is not a requirement of CERCLA or any ARAR identified in this IM/IRA. However, Appendix A identifies the engineered controls, including inspection and reporting requirements and frequencies, which will be implemented for the proposed action. Details of maintenance and inspection will be included in the Maintenance and Monitoring Plan.
	Long Term Stewardship – Monitoring – Enforceability	
36	The State Environmental Covenants law should apply to the entire site, including the Present Landfill. This law would provide an additional layer of institutional controls, and DOE's own stewardship guidance recommends layering of controls.	This comment is beyond the scope of the Present Landfill IM/IRA. The RFCA Parties are discussing the applicability of this statute to the federal government. Additionally, the proposed action for the Present Landfill presented in the IM/IRA is an accelerated action under RFCA; therefore, the Environmental Covenants Law is currently not considered an ARAR for the Present Landfill.

37	Does the National Pollutant Discharge Elimination System (NPDES) exemption apply in this case?	Section 6.4 describes the NPDES permit waiver requirements as it applies in this IM/IRA. In addition, please see the discussion to question 2 in the letter (attached) dated October 17, 2003 from John L. Watson of Moye Giles LLP to Jerry Henderson, RFCAB.
38	The site has indicated that it may eventually seek delisting of the leachate. What is the time frame for delisting? How many data points would be required to support a delisting petition? Is the East Landfill Pond considered a land disposal site, and if so, are there any plans to delist it?	The East Landfill Pond is not a land disposal unit.
39	Would regulatory enforcement be lost if leachate ceases and is no longer being released to the waters of the state?	Please see the discussion to question 2 in the letter (attached) dated October 17, 2003 from John L. Watson of Moye Giles LLP to Jerry Henderson, RFCAB.
40	Identify points of compliance or point source areas.	The IM/IRA states that eight (four upgradient and four downgradient) RCRA groundwater monitoring wells have been established for the Present Landfill pursuant to RFCA and RCRA. The IM/IRA also states that the existing downgradient RCRA groundwater monitoring wells will be groundwater POC wells for RFCA Attachment 10. Additionally, surface water monitoring for No Name Gulch is conducted at the existing Indiana Street surface water point of compliance.
	Surface Water **National Pollutant Discharge Elimination System (NPDES) Criteria**	
41	The permit-like instrument should have the full force of law under the Clean Water Act rather than CERCLA. RFCAB is concerned that under CERCLA, non-attainment of water quality standards would carry no enforceable repercussions.	Please see the discussion to question 4 in the letter (attached) dated October 17, 2003 from John L. Watson of Moye Giles LLP to Jerry Henderson, RFCAB.
42	Monthly for at least one year and at regular intervals thereafter, there should be an evaluation of influent to and effluent from the seep treatment unit, with respect to analytes as identified in the Integrated Monitoring Plan, including but not necessarily limited to inorganics, organics, metals, whole effluent toxicity, gross alpha / beta, physical parameters, asbestos, BOD and COD. The purpose of this sampling would be to support a data analysis with the objective of determining which pollutants have a reasonable potential of being present in the seep.	The IM/IRA (See Appendix A) describes the monitoring requirements for the seep. Monitoring will be conducted quarterly which will provide sufficient data points to determine seasonal and long-term trends. If the effluent limits are obtained, then the treatment unit is effective. Monitoring of the influent to the seep treatment system will be included to the monitoring plan for the seep. The constituents currently associated with the Present Landfill seep and identified in this decision document are benzene and vinyl chloride. RFCA parties agreed, based on historical monitoring data for the seep, that good indicator parameters for changes in the seep water quality are VOCs and

		metals. If in the future statistically significant changes to the seep water quality are observed, the RFCA parties will evaluate if the monitoring program or the treatment system should be changed. Whole Effluent Toxicity (WET) Test, Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD) are not chemical specific standards for which stream standards exist. Instead these are a class of discharge conditions that may indicate an impact to a receiving water. There is no evidence of these conditions having an impact on the East Landfill Pond. In addition, we have established that we do not have levels (in part per million or ppm) of any contaminant that would trigger these kind of conditions. RFETS believes that based on the water quality for the Present Landfill seep and East Landfill Pond water, that BOD and COD would not be exerted at levels of environmental concern.
43	In the future, further evaluations during the CERCLA review or other post-closure decision document evaluation, DOE, the regulators, and stakeholders should determine which parameters to retain after the cap is in place.	This comment is beyond the scope of the Present Landfill IM/IRA. The RFCA Parties are currently negotiating modifications to RFCA to address the post-closure period.
	Surface Water – Pond Management	
44	RFCAB understands that the site is proposing to modify the outlet structure of the East Landfill Pond to allow it to flow into No Name Gulch. RFCAB believes the site should evaluate potential effects on this previously unaffected drainage. The CAB is adamant the current scheme whereby this water is routed to the A-Series ponds should continue.	Based on historic samples, the Present Landfill has not impacted water quality at the East Landfill Pond and DOE believes that it is reasonable to retain the pond's existing outlet structure to allow water in the ponds to flow into the existing drainage when the water level reaches a specific level. The seep will be sampled after treatment and prior to discharge to the East Landfill Pond. If an elevated level is detected, then the East Landfill Pond water will be sampled. If the East Landfill Pond water sample contains levels above the action levels in RFCA Attachment 5, Table 1, then the RFCA Parties will evaluate if the East Landfill Pond water can be released or managed in another way. East Landfill Pond water will not be sampled prior to release unless there is a seep treatment system sample result above effluent limits.
45	Will the East Landfill Pond sediments be remediated if found to be above human health or ecological soil cleanup criteria, or levels associated with RCRA listed or characteristic hazardous waste?	The IM/IRA has been revised to include the removal of the sediments from the East Landfill Pond and place the sediments under the RCRA-compliant cover of the Present Landfill.
	Surface Water - F039 (Leachate) Delisting	
46	Please identify the minimum criteria for delisting leachate.	Under the regulatory approach described in the IM/IRA delisting of the leachate is not required. If the regulatory approach were to change in the

		future and it is determined that delisting is required, then the delisting process required in 6 CCR 1007-3 §§ 260.20 and 260.22 would be followed.
47	RFCAB believes stakeholder involvement is necessary at each step of this process.	DOE concurs with this comment.
	Cover Design – QA / QC	
48	The site must ensure that the cover is constructed according to procedures that meet rigorous QC requirements, with QA oversight of the contractor provided by an independent expert.	K-H and an independent contractor will provide QA/QC.
	Cover Design – Cobble Layer	
49	The Board is concerned that the riprap appears to be only one-layer-thick, and believes that a single layer of cobbles is not sufficient to prevent intrusions into the cover.	The proposed cover configuration has been modified above the geosynthetic liner to provide a vegetative cover (See attached cover cross-section). The cobble layer is now above the geosynthetic liner and covered with 2-feet of soil. The cobble layer is 1-foot thick.
50	More information is needed on the mix of different sized cobbles to be used, in order to evaluate effectiveness and degree of maintenance required for this layer.	The specification for the cobble layer will be similar to the biota layer used at the hazardous waste landfill at the Rocky Mountain Arsenal and will be specified in the detailed design.
51	Weed management also needs to be addressed. The use of herbicides may harm water quality.	Appendix A identifies the engineered controls, including inspection and reporting requirements and frequencies, which will be implemented for the proposed action, including vegetation control. The DOE and regulators will approve any use of herbicides. Details of maintenance and inspection will be included in the Maintenance and Monitoring Plan.
	Cover Design – Freeze-Thaw Cycles	
52	The cover design must ensure manmade materials in the critical barrier layer remain below the frost line.	As presented in the IM/IRA, the GCL will be placed below the frost line calculated during the detailed design.
53	In calculating necessary soil cover depth, the site should make conservative assumptions resulting in at least a 95% confidence level that the liner materials will be protected even under extreme conditions.	This consideration will be included in the detailed design.
	Cover Design – Warranty / Bonding	
54	What is the warranty on the cover materials and installation?	Warranties will be considered and specified in the detailed design.
	Applicable or Relevant and Appropriate Requirements (ARARs)	
55	RFCAB is concerned that some potential ARARs were not considered. Examples include the Colorado Solid Waste Disposal Regulations pertaining to explosive gas control and the NRC regulations on disposal of radioactive waste.	Because of the low rates of gas production, landfill gas is not a hazard that must be addressed through this action. The existing vents will be removed. New vents will be designed and installed as a part of the proposed cover

		configuration under RCRA subtitle C ARARs. The vents primary purpose will be to provide barometric venting required for covers with an FML; however, it will also vent any further methane production from the landfill. The Present Landfill was not used for disposal of radioactive waste, although some small volume of waste materials believed to be contaminated with low concentrations of radioactive materials may have been disposed. These materials do not trigger an accelerated action at the Present Landfill. The appropriate substantive provisions of the NRC "decommissioning rule", 10 CFR 20 subpart E, which has been adopted by Colorado in it's radiation control regulations, will be ARARs for the final response action related to radioactive contamination that may exist at RFETS.